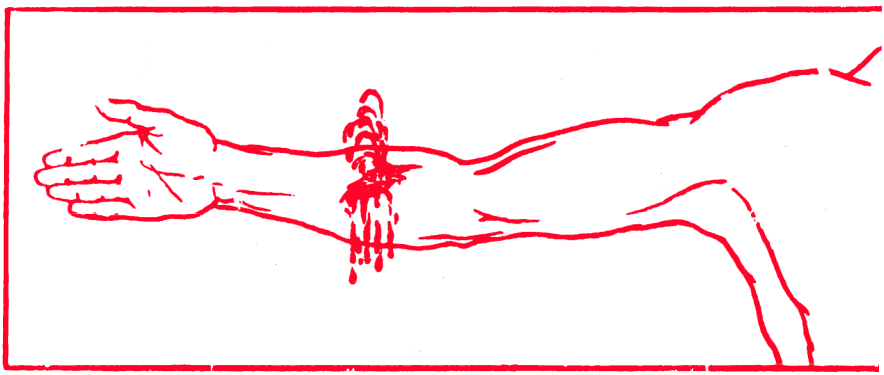
# Accident First Aid

V. V. YUDENICH



MIR PUBLISHERS MOSCOW

В. В. КОДЕНИЧ

# ПЕРВАЯ ПОМОЩЬ ПРИ ТРАВМАХ

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V. V. YUDENICH

# Accident First Aid

Translated from the Russian by
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A person's life and work are closely linked with his environment. The development of industry and transport, mechanization of agriculture, and general acceleration of life's tempos often create conditions for injuries of various kinds.

In spite of sensible measures aimed at industrial safety and the development of safety devices and techniques, the frequency of accidents is still high in industry, and especially in everyday life.

The character of injuries, and the way they are inflicted vary greatly. They often call for immediate first aid because they are attended with grave complications and can be fatal. It is therefore necessary to render the victim aid as soon as possible on the spot, and send him for treatment to an institution that has facilities for rendering qualified medical aid, and where necessary surgical treatment.

The life of a person who has sustained grave injuries, and the outcome of further treatment, often depend on prompt proper first aid. Knowledge of the elements of self-aid and help for others is particularly essential in situations of mass accidents and natural disasters (fires, earthquakes, etc.), transport and industrial accidents, and so on. There is always a lack of medical personnel in such situations, and the victim's life depends mainly on how he and those around can use improvised first-aid facilities, and help themselves and others.

Our booklet is intended to help people who have no medical training to learn ways and methods of coping with such situations and rendering themselves and others first aid.

## TRAUMAS AND THE SCOPE OF FIRST AID

Traumas are injuries to the body and its organs caused by various mechanical, temperature and chemical factors and electricity.

The existence of multiple injuries differing in character and gravity causes them to aggravate each other and greatly worsen the victims' state.

Most countries have Red Cross organizations and/or emergency ambulance service that can be mobilized to render aid to the victims of natural disasters (floods, earthquakes, hurricanes, avalanches, etc.) or large-scale accidents and incidents (fires, multiple road accidents, crowd incidents, etc.).

Injuries often occur at work both in industry and on the farm, during the repair, maintenance and operation of vehicles of various kinds, during games and sport, and in various everyday situations. They often happen by accident, so that it is impossible in practice to anticipate the time and place of an accident. For that reason, it is very difficult to organize medical care to victims on the spot of the accident and first aid has often to be reduced to self-help or mutual assistance, until more qualified aid is forthcoming from a first-aid post, ambulance crew, Red Cross team, etc.

In ordinary cases, however, first aid is often rendered by a bystander or passer-by, or someone who is present.

When it is rendered by someone who was not present at the time of the accident it is necessary to establish more exactly when the trauma occurred, where and in what circumstances, and also what caused it. That often makes it easier to recognize the character of the injury and to choose the right method of first aid quickly. It is particularly important to know the circumstances of an accident and the way the injury was caused when the victim is unconscious and cannot say what happened.

First aid needs to be immediate in severe accidents complicated by bleeding, shock, and loss of consciousness.

First aid is a combination of simple but quite expedient, active measures to save the victim's life and prevent possible complications.

Anyone rendering first aid must know how to determine the character and severity of the injury, and how, when necessary, to take urgent steps to control disturbances of breathing and heart action, to stop external bleeding, bandage wounds, immobilize the injured part of the body in fractures, lift the victim properly, move him, and remove his clothes, load him onto transport, and so on. It is very essential for all that to know how to use improvised means, remembering that the victim's life often depends on the initiative and resourcefulness of those rendering first aid and their skill in making use of materials at hand.

In order to find out the character of an injury and render first aid it is necessary to provide access to the affected part. Clothing is first removed from the sound arm or leg and then very carefully from the injured one.

When the injury is severe, especially one with damaged bone, and it is necessary to arrest bleeding and immobilize the limb, clothing should be cut or torn along the seam. Boots should be cut along the back seam of the uppers. Sometimes, in order to apply a bandage, it is sufficient to cut a hole (or flap) in the clothing of the appropriate size.

In all cases when the victim is carried or transported care must be taken to cause him as little pain and additional damage as possible through awkward movements, an uncomfortable position, and jerking and bumping.

Severely injured persons, especially those with fractures and/or extensive wounds, are best lifted and moved by three persons, supporting them by the calves, buttocks and back (Fig. 1). They must act together and cautiously, taking care to avoid any bending or sagging of the separate parts of the body. In less severe cases, or by force of circumstances, one or two persons may carry an injured person. Victims may be carried on a stretcher, on the shoulders, in the arms, by means of a pole or stick, or on a blanket, or lashed skis, etc. (see Figs. 2-5).

When a stretcher is not available, one can be improvised by inserting poles into the sleeves of a coat turned inside out (Fig. 5), or into a folded blanket, bag, or straps.

An injured person should be carried head first so as to be able to watch his condition. This position is also

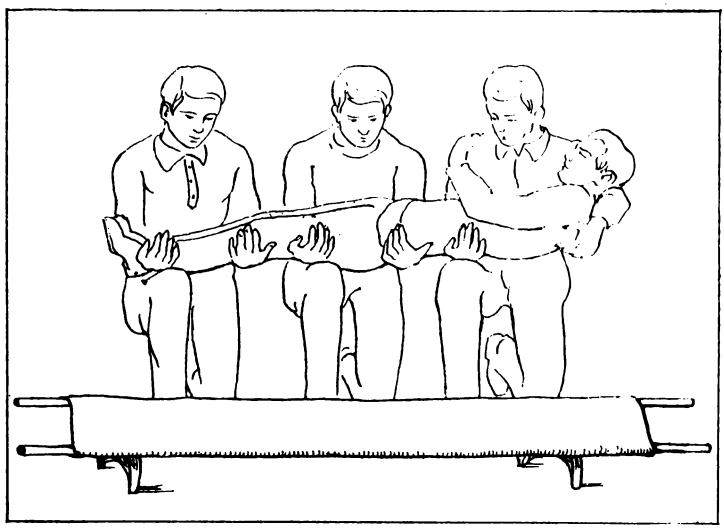
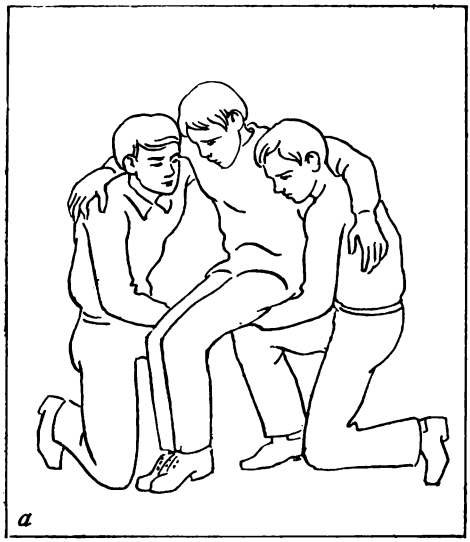


Fig. 1. Lifting and moving an injured person on a stretcher by three persons

convenient if he has to be carried uphill. When going downhill or descending stairs the stretcher should be kept horizontally and be lifted or put down synchronously by two persons.

A medical stretcher is the best means for carrying and transporting severely injured persons. It is agonizing and dangerous for such patients to be shifted into another stretcher, especially when they have fractures of the long bones or penetrating wounds; they should therefore be taken to hospital or wherever on the same stretcher. There are also rules for putting an injured person into an ambulance; the stretcher and the victim are pushed in head first on the roller or trolley.

When there are several victims the stretchers may be put into specially equipped ambulance vans in two or three tiers first filling the upper and then the lower ones. Seriously injured persons should be placed on the bottom tier. In cold weather it is necessary to keep the victims warm, especially those who have suffered shock or lost much blood.



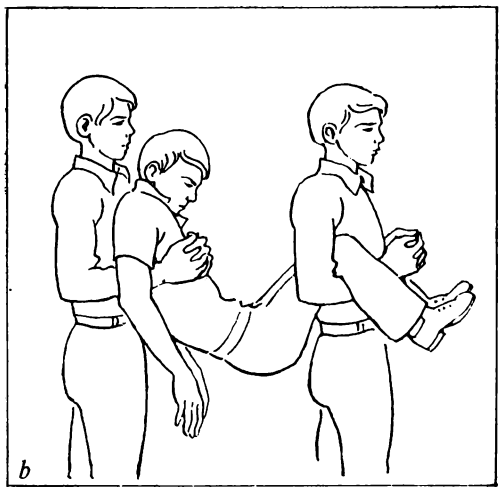




**Fig. 2.** *a*, a victim is carried by two persons (first method); *b*, a victim is carried by two persons (second method)

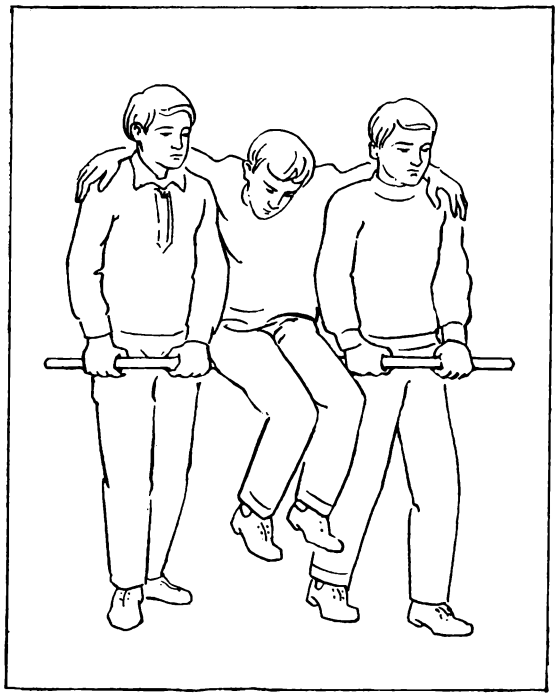


Fig. 3. A victim is carried by means of a stick

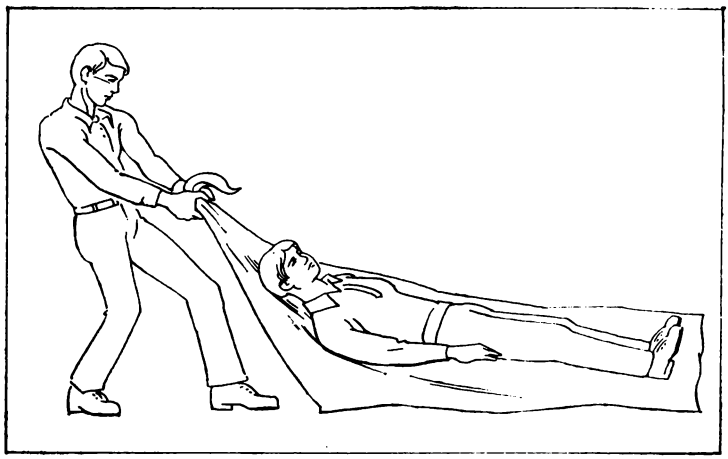


Fig. 4. A victim is carried by means of a blanket

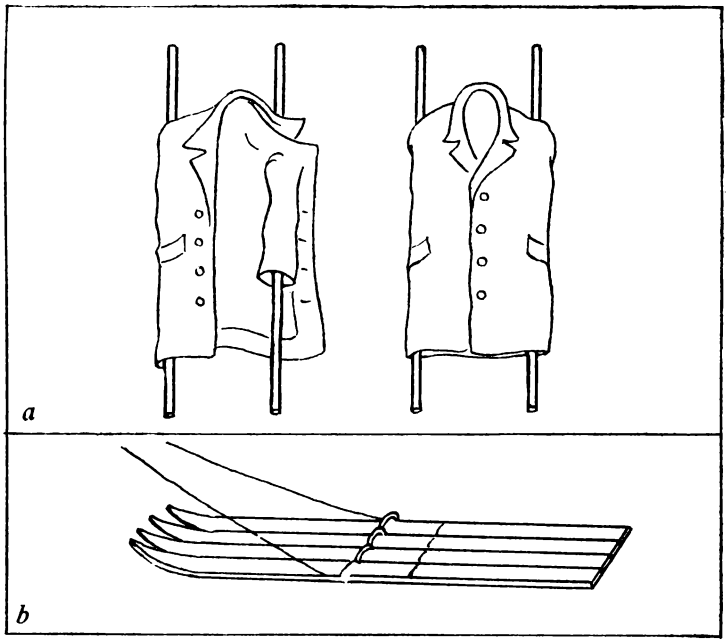



Fig. 5. Improvised means for transportation of victims
*a*, a stretcher made of overcoat; *b*, a stretcher made of skis

## WOUNDS AND BLEEDING

Wounds are open injuries with a break in the skin or mucous membranes. The following types are distinguished: gun-shot wounds (bullet, shell, or shrapnel), incisions (cuts), abrasions, punctures (stabs), contused wounds, lacerations (tears), contusion (bruising), and bites. They may be perforating, blind, tangential, penetrating (into closed cavities like the skull, chest, abdomen, joints), or nonpenetrating.

Incised and punctured wounds usually have smooth, even, only slightly broken edges. Contused wounds, and especially gun-shot wounds, have a large area of damage, which creates conditions very favourable for the development of infection; they therefore heal more slowly and often suppurate. Exceptions are certain bullet wounds perforating soft tissues but not penetrating cavities of the body, and superficial shell and shrapnel wounds.

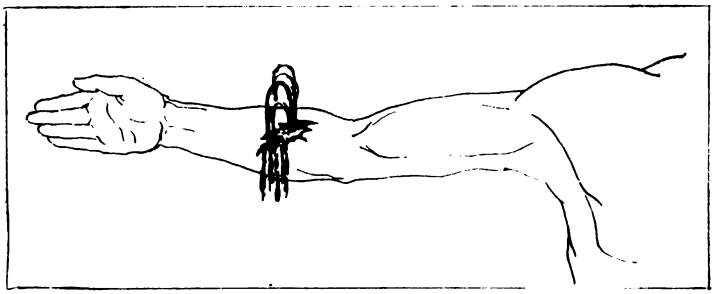


Fig. 6. Arterial bleeding

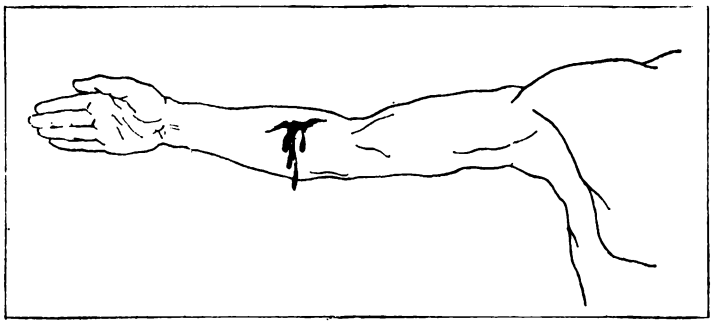


Fig. 7. Venous bleeding

All wounds received in accidents become contaminated by germs from the skin, clothing, soil, and more or less all objects around. Germs getting into a wound with the object causing it find a good medium for their development there. The destroyed, dead tissues serve as a nutrient medium, especially when there is a large area of damage (e.g. in gun-shot and contused wounds).

The commonest infectious complication of wounds is suppuration. Signs of it appear locally or generally within five to seven days of injury. Local signs are an increase in the pain of the wound, inflammation of the skin around its edges, swelling, and a feeling of heat. Sometimes, when the inflammation spreads to the subcutaneous cellular tissue, red streaks appear on the skin running along the lymphatic vessels (a condition known

as lymphangitis). The lymph glands located centrally to the site of the wound enlarge, swell and become painful to the touch. When a wound in the area of the foot, shin or thigh suppurates, for instance, the lymph glands in the groin of the affected side swell; with inflammation of the wound on the arm the lymph glands in the armpit swell. Inflammation of the lymph glands is called lymphadenitis.

With marked festering of wounds a patient's condition deteriorates: his temperature rises, pulse accelerates and there is sometimes shivering. These symptoms become even more marked when there is an extensive zone of suppuration. Persistence of a purulent focus can lead to general blood poisoning or septicaemia.

Purulent processes are caused by various germs, most often by staphylococci, streptococci, *Proteus*, colibacilli, or the bacillus of blue pus. In addition to these microorganisms, a wound may contain others that cause gas gangrene. They discharge poisonous substances (toxins) that cause swelling and an accumulation of gas in the tissues, a complication that is very dangerous. The gravest infectious complication of wounds is tetanus, which is caused by the tetanus bacillus widely spread in nature. The spores of this bacillus are very resistant and are found in the soil and on objects. When the conditions in a wound favour its development, the tetanus bacillus secretes a strong toxin that affects the neuromuscular system and leads to severe convulsions and destroys red blood cells, the blood's oxygen carriers.

A very effective means of preventing the development of this dangerous complication is the injection of all wounded persons with tetanus antitoxin or tetanus anatoxin.

Suppuration is caused by germs getting into a wound from the surroundings either at the time of the injury or later if the wound is not covered by sterile (aseptic) bandage.

Every wound is attended with bleeding varying in character and strength. Arterial, venous, capillary, and parenchymatous bleeding is distinguished. Blood may escape externally (surface bleeding) or flow into internal cavities of the skull, thorax, and abdomen in which case the bleeding is called intracavitary.

Very profuse bleeding occurs when major arteries are

wounded (the carotid, subclavian, axillary, brachial, femoral and popliteal arteries). Blood escapes from the arteries at high pressure and if the bleeding is not arrested promptly the person may bleed to death in a few minutes.

*Arterial bleeding* is easily recognized by the presence of a tense, pulsating, sometimes spurting stream of bright-red blood (see Fig. 6).

*Venous bleeding* occurs in wounds of the veins. The blood pressure in veins is much lower than in arteries so that the blood flows more slowly, in an even stream, and is of a dark-cherry colour (Fig. 7). Compression of the vein above the site of the wound not only does not stop the bleeding but may even intensify it. Therefore, with profuse bleeding the main artery must also be compressed in order to stop the flowing of blood to the affected part of the body.

Venous blood is moved by muscle contraction and the 'sucking' action of the heart, so that when there is a gaping wound on the wall of a major vein (especially in the neck), bubbles of air may be sucked into the blood from outside. Air bubbles getting into the blood stream can plug the cardiac and cerebral vessels, so causing the grave, often fatal complication known as air embolism.

*Capillary bleeding* is caused by damage to the smallest blood vessels (capillaries), generally in the skin or mucous membranes. Blood oozes for some time over the whole surface of the wound but soon clots and the bleeding stops spontaneously.

Wounds of the internal organs (liver, spleen, kidneys, or lung), which are specially rich in blood vessels, cause profuse bleeding (known as *parenchymatous*).

With damage to the smaller blood vessels the bleeding usually stops by itself through the organism's defence function, i.e. the blood's ability to coagulate or clot. Clots of the coagulated blood plug the wound in the vessel and the bleeding stops. When larger vessels are damaged, the clots formed cannot resist pressure of the blood and stop the bleeding reliably.

Various methods can be used to stop external bleeding temporarily.

With mild venous or arterial bleeding a tight bandage is applied and the area of bleeding raised.

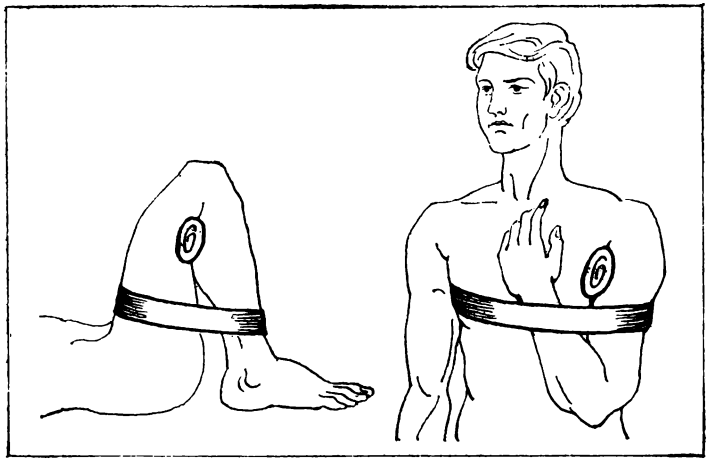


Fig. 8. Arrest of bleeding by maximal bending of limbs in the joints. For better compression of the major arteries a roller made of cotton wool and gauze is put under the knees and armpit

It is sometimes possible to arrest bleeding by compressing vessels by bending the limb at the joint; with bleeding of the shin the leg should be bent at the knee as fully as possible, with bleeding from a wound in the forearm the arm should be bent at the elbow (Fig. 8.) By pressing the shoulder backward strongly the subclavian artery can be compressed between the collar bone and the first rib. This method can be used to reduce bleeding from wounds at any level of the arm, or in the area below the collar bones and armpit.

Profuse, dangerous arterial bleeding from a wound in a limb calls for emergency measures, which consist in applying a tourniquet. But before a tourniquet is applied the bleeding vessel must be quickly compressed above the site of the injury (finger pressure).

The *carotid artery*, which supplies blood to the head and neck, can be pressed against the transverse process of the fourth cervical vertebra in the middle of the neck in front of the sternocleidomastoid muscle.

A damaged *subclavian artery* is pressed against the first rib above the collar bone, at a point located at the edge of the inner third of the collar bone. The *axillary artery* can be pressed against the head of the humerus

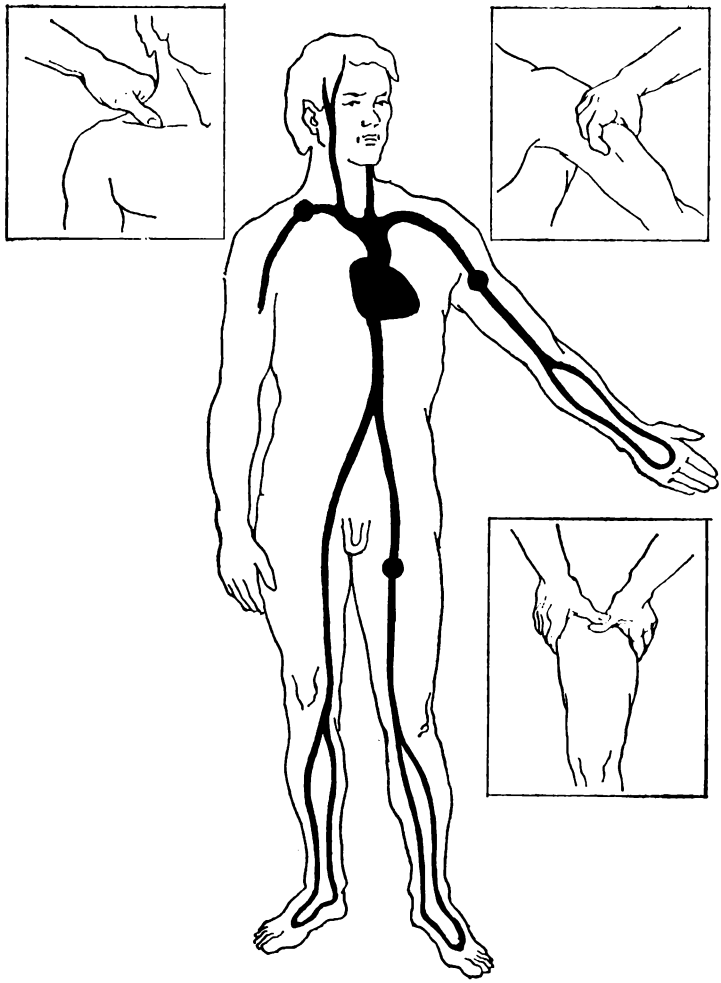


**Fig. 9.** Main points of compression of major arteries

in the armpit. The *brachial artery* is pressed against the humerus at the inner margin of the biceps, and the *femoral artery* in the groin against the horizontal ramus of the pubis (Figs. 9 and 10).

Finger compression of a trunk artery is a forced measure, possible only for a brief period, because it is very

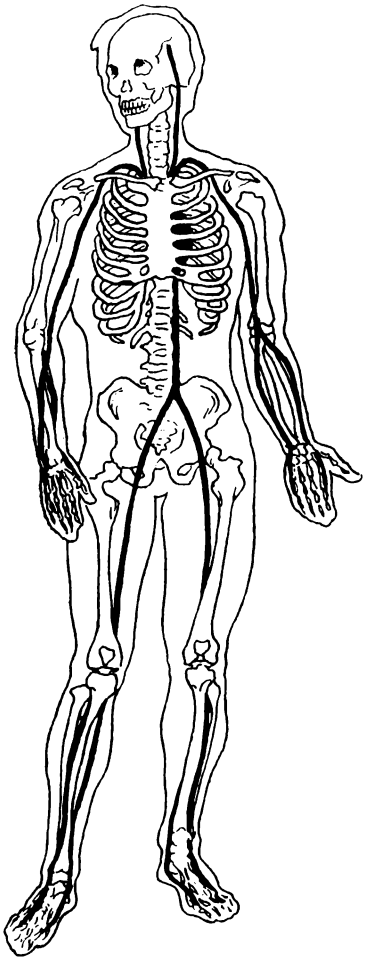


Fig. 10. Distribution of major vessels relative to bones of the skeleton

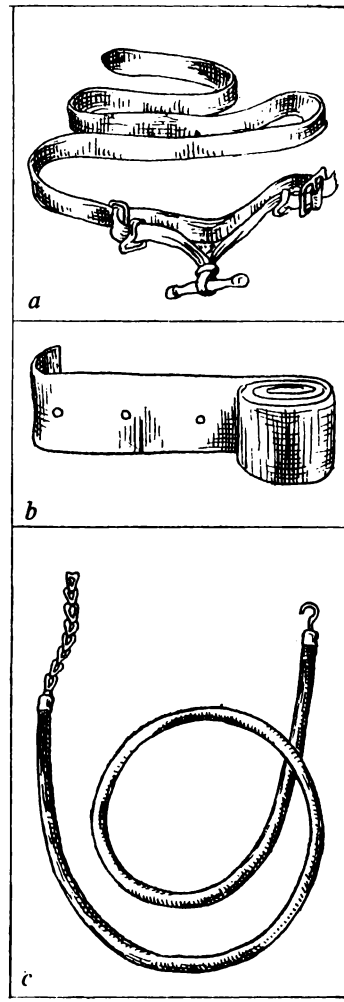



Fig. 11. Types of tourniquets *a*, linen tourniquet; *b*, band tourniquet; *c*, Esmarch's tourniquet

difficult to press a vessel for a long time, apart from the fact that strong pressure on the nerves running along vessels causes pain. So a vessel should be pressed with the fingers only until a tourniquet has been applied.

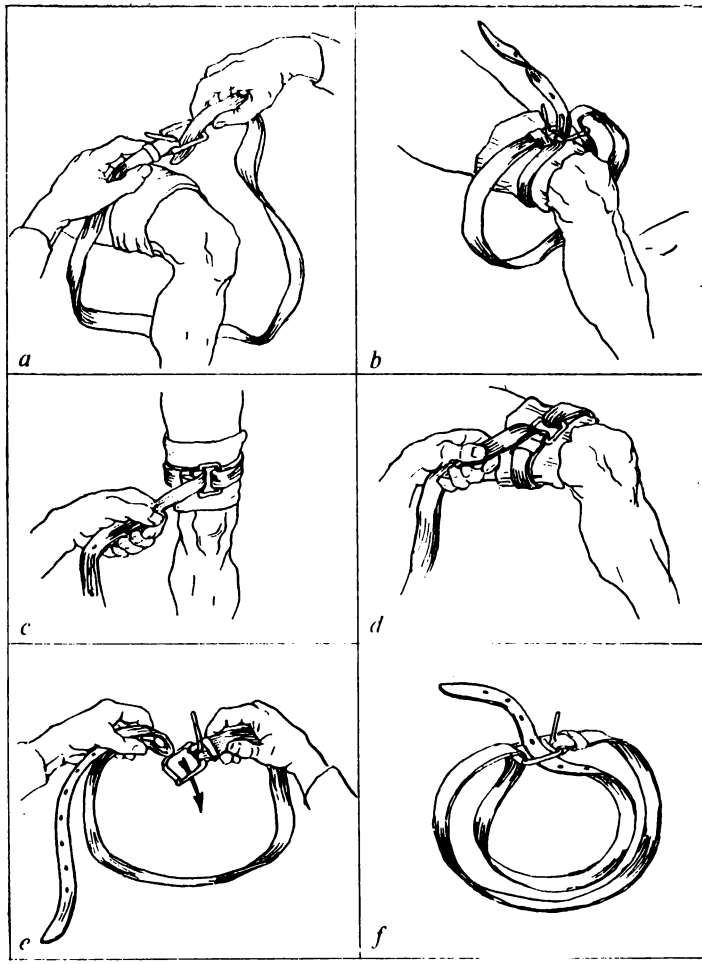



**Fig. 12.** Use of a belt as a tourniquet
*a, b, c, d,* stages of application of tourniquet; *e, f,* preparation of a double loop

There are several types of tourniquet, the most common ones are made of rubber. Esmarch's bandage or tourniquet consists of a strong rubber tube 1.5 metres long with a metal chain at one end and a hook at the other. More elastic rubber tourniquets are made as flat bands (see Fig. 11).

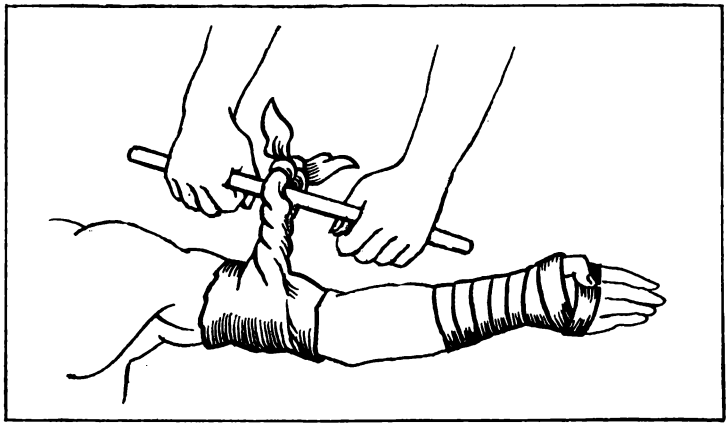


Fig. 13. Arrest of bleeding by a twist

Fabric tourniquets are not elastic, so they have to be tightened by twisting them. Any rubber band or tube, a belt, braces, a necktie, etc., can be used as an improvised tourniquet (Figs. 12 and 13).

A tourniquet, whether standard or improvised, is applied above the wound and as near as possible to it.

A tourniquet should not be applied to the middle of the shoulder because of the danger of compressing the

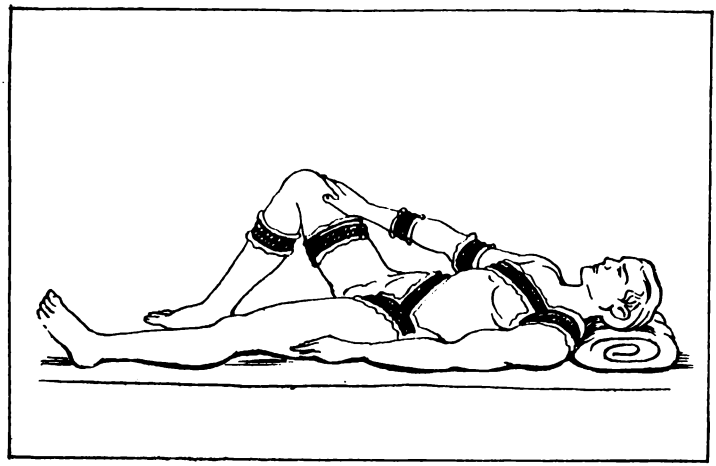


Fig. 14. Sites of application of a tourniquet

radial nerve and causing paralysis (Fig. 14). A tourniquet is applied over the clothing or a soft pad (a towel or handkerchief folded several times and tied around the limb) so as to reduce the pain and prevent possible pinching of the skin.

A rubber tourniquet is stretched by both hands, wrapped several times around the limb, and tied. It should be tightened enough to stop the bleeding, which will make the limb go pale. Too tight tourniquet can damage nerves and cause paralysis of the limb, but if it is not tight enough the limb does not pale but becomes bluish and the bleeding becomes more profuse because of artificial congestion of the veins.

An improvised tourniquet made of fabric is wrapped two times around the limb and pulled as tight as possible. It is then tightened further by twisting it with a stick inserted into the knot until the bleeding stops (Fig. 13).

A tourniquet should not be left in position more than an hour, after which it should be cautiously loosened to restore circulation. If bleeding continues it should be moved a bit higher and tightened again. A tourniquet should not be applied for more than two hours, otherwise gangrene might result. Because of that the time of application of a tourniquet should be noted on a piece of paper and fastened in a conspicuous place on the outer clothing.

A victim with an applied tourniquet must be taken immediately to a medical institution where the bleeding will be arrested completely by tying the end of the injured vessel or applying vascular sutures. In cold weather a limb with a tourniquet must be well wrapped and the patient kept warm as possible.

## ACUTE ANAEMIA

Acute anaemia occurs when a considerable amount of blood is lost. Since an adult has five litres of blood in the circulation the loss of more than a litre and a half is already very dangerous. The rate of blood loss is also very important, so that bleeding from an injury to the larger arteries is especially dangerous.

Women sustain blood loss more easily than men; loss of 250 to 300 ml of blood is, however, fatal to an infant under one year of age.

With heavy loss of blood symptoms of acute anaemia develop. The victim complains of general malaise, thirst, giddiness, and everything going dark before his eyes. The skin and mucous membranes of the lips and eyelids become very pale, the eyes become sunken, yawning begins, the features of the face sharpen, a cold sweat breaks out on the forehead, the pulse quickens to 120 and more per minute, weakens and becomes difficult to count. Blood pressure drops. This is followed by loss of consciousness, dilatation of the pupils, and involuntary urination and defaecation. If such a patient does not receive prompt help he may die of paralysis of the respiratory and circulatory centres because of oxygen hunger of the brain.

External bleeding must be stopped immediately by any of the methods described above. After that the patient should be given plentiful to drink.

The vitally important respiration and circulation nerve centres in the brain suffer first from deficient circulation. For that reason it is necessary to intensify flow of blood to the head and heart. The patient is placed so that his head is lower than his feet, by raising the foot end of the bed and removing the pillow from beneath his head. This promotes flow of blood to the brain and helps gain time for getting the victim to a medical institution where the bleeding can be completely arrested and a blood transfusion given.

## TRAUMATIC SHOCK

With severe mechanical traumas (multiple fractures, and particularly gun-shot fractures of the bones, severing of a limb, rupture of internal organs) a general reaction may set in, displayed in inhibition of the organism's vitally important functions. This state is known as shock.

The reason for the development of shock has not yet been fully clarified, but loss of blood and overexcitation of the nervous system contribute greatly to its occurrence. Drop of blood pressure and constriction of the peripheral blood vessels cause disturbances of tissue nutrition and oxygen hunger. The patient's state is aggravated by absorption of poisonous substances of protein

breakdown from the affected area and metabolic disorders.

Development of shock is promoted by heavy loss of blood, chilling, overexertion, hunger, secondary trauma from careless shifting of the injured person, transportation on a bad road in an unsuitable vehicle and without proper anaesthesia and splinting of fractures.

A classical description of the clinical picture of traumatic shock was given by the famous Russian surgeon N. I. Pirogov. He termed it 'numbness' and described it as follows: 'Such a numbed subject with a severed arm or leg lies motionless in the dressing station; he neither shrieks nor screams, and does not complain of anything; he does not take part in anything and does not demand anything; his body is cold, his face is as pale as a corpse; his glance is fixed and remote; his pulse is thready, hardly palpable, and intermittent. A numbed person either does not answer questions at all or does so to himself, in a hardly audible whisper; his breathing is also hardly noticeable. The wound and skin are almost quite insensitive, but if a large nerve end protruding from the wound is irritated by anything the patient's only sign of feeling is a contraction of his facial muscles. Sometimes this state passes in a few hours, in other cases it lasts without change until death'.

Three degrees of shock are distinguished. First degree shock is a state of compensation—pallor and weakness, general condition good; pulse rate 90 to 100, maximal blood pressure above 100 mm Hg. Second degree shock —a state of partial compensation: the general condition poor, weakness, pallor, anxiety, cold sweat, occasionally vomiting; pulse rate 120 to 140, weak, barely countable; maximal blood pressure around 70 to 80 mm Hg. Third degree shock is a state of decompensation—general state very grave, marked weakness and pallor, cold sweat, thirst and vomiting; pulse rate 120 to 160, barely countable; maximal blood pressure drops below 70 mm Hg.

*First aid.* Any bleeding needs to be stopped immediately; when there is a gaping wound of the chest (open pneumothorax) a germetic bandage is applied; with fractures the limb is immobilized and an anaesthetic given. The patient should be warmed and if no internal organs are damaged be given hot tea, coffee, or a sip of vodka or wine.

## THE COMPRESSION SYNDROME

With a long-continued compression of the legs by anything heavy (the bricks of a collapsed wall, earth, logs, etc.) a peculiar clinical picture develops resembling shock, even when the patient has no severe wounds or fractures.

Symptoms typical of shock (pallor, cold sweat, general weakness, sluggishness, inhibition, drop of blood pressure, weakening and acceleration of the pulse) do not appear immediately but several hours later, after the compression has been relieved. Insufficiency of renal function develops two or four days after the accident; the output of urine is much reduced, the general condition deteriorates rapidly and jaundice, vomiting, and delirium develop (from intoxication caused by disturbance of the working of the liver and kidneys). The legs swell and become hard and bluish with white spots; pulsation of the arteries cannot be felt in them. The leg muscles grow numb because of the disturbances of circulation.

*First aid.* The victim should be released from the compression and his legs immobilized. If possible, they should be surrounded with ice, an anaesthetic administered and the victim taken to hospital as rapidly as possible, but gently and carefully.

## FAINTING

Sudden, temporary loss of consciousness owing to rapidly developing anaemia of the brain is a frequent complication of various injuries. Fainting occurs with strong emotional strain, and with pain caused by clumsy manipulations during bandaging, or shifting, or jolting during transportation.

When a patient faints, he suddenly turns pale, loses consciousness and does not respond to such external stimuli as calls or pricks. The pulse accelerates and weakens, the pupils are dilated and when fainting is deep do not respond to light. The state of unconsciousness usually lasts from a few seconds to several minutes.

*First aid.* The patient should be laid flat on his back with his head lower than his feet, and his (her) collar, belt, braces, or brassiere loosened or unfastened so as

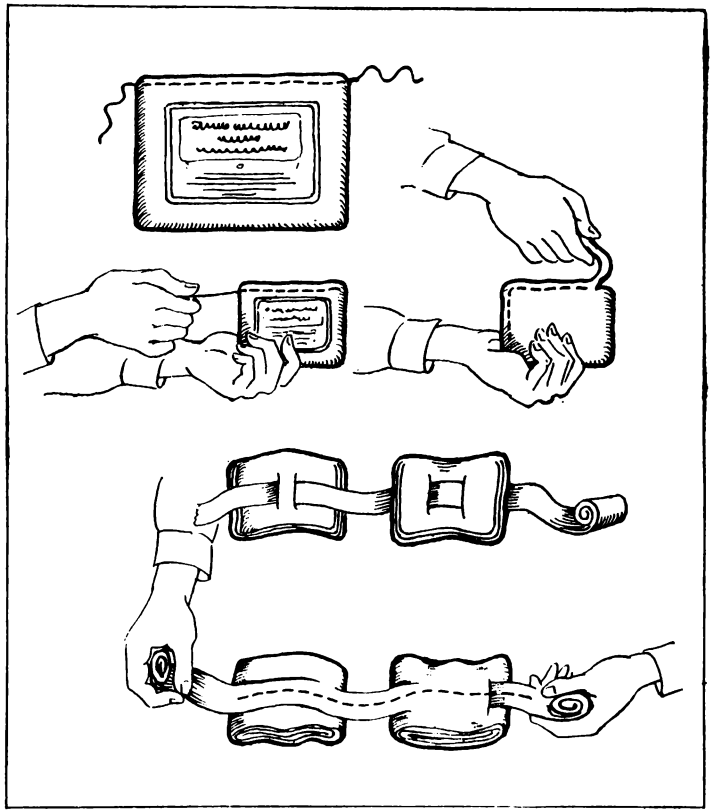


Fig. 15. Individual first-aid dressing pack

to provide a free circulation of air; he (she) should be given a sniff of ammonium hydroxide or smelling salts, and lightly slapped on the cheeks. Water should be sprinkled on the face. Artificial respiration and cardiac stimulants are sometimes applied.

## RULES FOR APPLYING BANDAGES

One of the essentials of the first aid in wounds is the application of an aseptic bandage to protect the wound from external effects and bacteria that could cause grave complications. Wounds must never be rinsed with water.

Before a bandage is applied the skin around the wound needs to be disinfected with either surgical spirit or iodine tincture. A sterile bandage is then applied. If a special first-aid dressing pack is available it is best to use it.

The **individual first-aid dressing packs** produced by the Soviet pharmaceutical industry contain a gauze bandage 7 cm wide and pads of cotton wool and gauze 9×6 cm, one of which is tightly fastened to one end of the bandage while the other can be moved as needed (Fig. 15).

The dressing material is wrapped in waxed paper with a pin in its fold inserted and packed in a rubberized envelope with slightly incised edges for quick release.

The edge of the envelope is torn off, the contents wrapped in waxed paper package removed, and the paper is carefully unwrapped, avoiding contact with the side of the pad that will face the wound.

With a perforating wound the fixed pad is placed over the entry of the wound and the other, movable one, over the exit, and they are fixed in place by the bandage.

The small sterile packed bandages are also produced, consisting of a cotton-wool and gauze pad 24 to 32 cm in an unrolled form secured to one end of a 13 cm gauze bandage.

When the wound or injury is extensive, particularly in burns, the patient should be wrapped in a clean, hot-ironed sheet.

Bandages may be securing (to keep a dressing on a wound), pressure (to arrest venous bleeding), and fixed (supporting).

**Triangular bandages** are convenient for supporting an arm in certain illnesses and injuries. Such a bandage can be made from a square of any material, by folding it diagonally. The bandage is placed under the forearm with the point at the elbow and the edge at 90° to the arm, and the ends are passed round the neck and tied in a reef knot at the back. The point is folded over the elbow and pinned at the front (see Fig. 16).

In another variant the point is placed over the elbow on the injured side and the ends are tied around the chest on the back in such a way that one is longer than the other. The point is then raised up over the elbow and

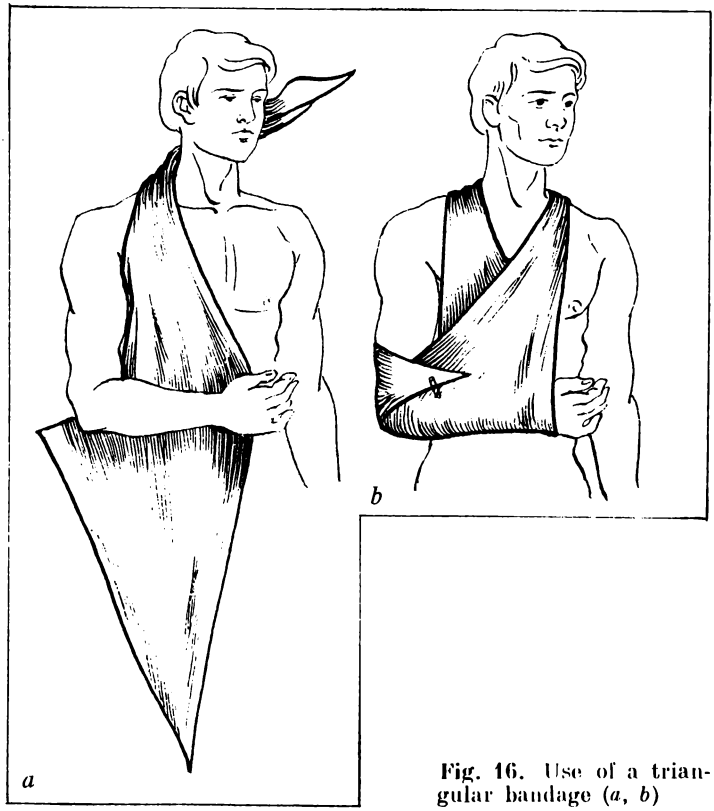



Fig. 16. Use of a triangular bandage (*a*, *b*)

tied at the back to the free long end. If the edge of the triangular bandage is not long enough the ends can be lengthened by tying roller bandage or twine to the two ends.

Triangular bandages can be used on any part of the body (see Figs. 17 and 18).

A **four-tailed bandage** can be made from a strip of gauze or a roller bandage by splitting it at both ends. This bandage is convenient for making a loop or sling to retain small dressings on the nose, chin, forehead, or back of the head (see Fig. 19).

A **T-bandage** can be made from two strips of gauze or bandage, one folded at right angles over the middle of the other. It is convenient for retaining dressings

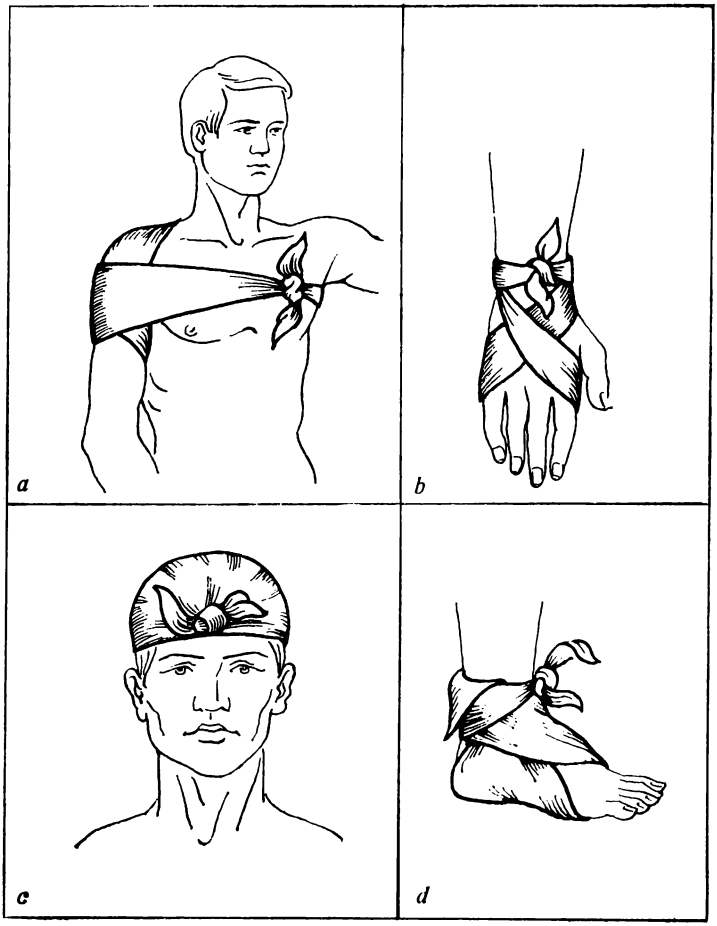



**Fig. 17.** Variants of triangular bandages
*a*, on the shoulder; *b*, on the wrist joint; *c*, on the head; *d*, on the ankle joint

on the perineum (Fig. 20). Gauze bandages are most common.

Certain rules need to be observed when bandaging. The bandaged part of the body should be in a comfortable position, and that in which it has to be after the bandaging (the physiological position). If this rule is not observed, and the limb is bandaged when bent, the dressing will slip off when the limb is straightened. Con-

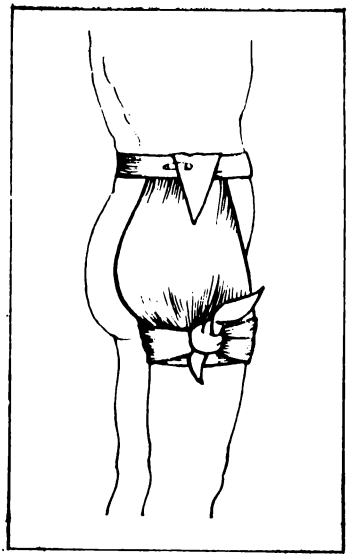


Fig. 18. Triangular bandage for the buttocks

versely, if a bandage is applied to a straightened arm which is then bent at the elbow the bandage will pull too tight and compress the arm, causing discomfort. Allowing for that, the elbow should be bandaged in a flexed position, the shoulder pulled out slightly from the body, the fingers slightly flexed so that the thumb can be moved easily. The lower limbs are bandaged with the leg extended and the foot at right angle to the shin.

The limbs are bandaged from the periphery to the centre, which prevents congestion of blood. The bandage is applied in one direction, usually clockwise, overlapping some of the preceding turn of each spiral, and is pulled tight so that it fits snugly exerting uniform pressure. When the bandaging is finished, the end of the bandage is torn up in the middle and the ends wound round the bandaged portion and tied. The bandage should not be applied too tightly so as to avoid circulatory dis-

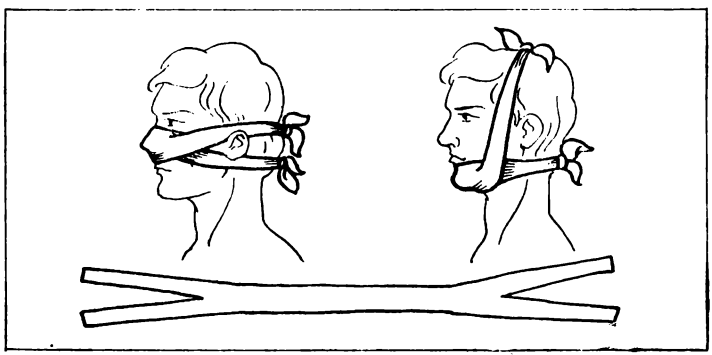


Fig. 19. Sling bandage

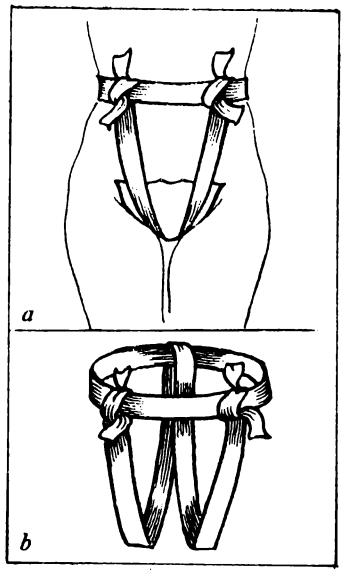



**Fig. 20.** T-bandage for the perineum (*a*, *b*)

turbances, and not too loosely so as to prevent its slipping from the wound.

**Circular (spiral) bandages.** The end of the bandage is pressed against the bandaged spot with the thumb of the left hand and the bandage is unrolled with the right hand, the spirals overlapping each other, and securing the first circle (see Fig. 21).

For a better fit and retention of the dressing on parts of the body that vary in thickness (e.g. shin, thigh or forearm) spirals with reverses are made (Fig. 22).

*Bandages of the head for wounds of the crown, back of the head and lower jaw (capeline bandages).* A piece 70 to 80 cm long is cut from a roller bandage and put over the crown of the head in such a way that two equal tapes hang down in front of the ears. These are held tight either by the victim or a helper. A roller bandage is wound round the head in several circles at the level of the forehead. The ends of the tapes are pulled downward and the bandage is circled around one of them. After that it is directed somewhat obliquely over the back of the head to the reverse end of the tape and also circled around it and, returning back, it is passed over the anterior part of the head nearer to the forehead. The first tape is again circled and the bandage is passed over the back of the head a little higher than the first time. The second tape is circled and the bandage continued over the front of the head. The turns of the bandage gradually meet at the middle of the top of the head and cover it completely like a cap. After that the ends of the vertically applied tapes are tied up under the chin (Fig. 23).

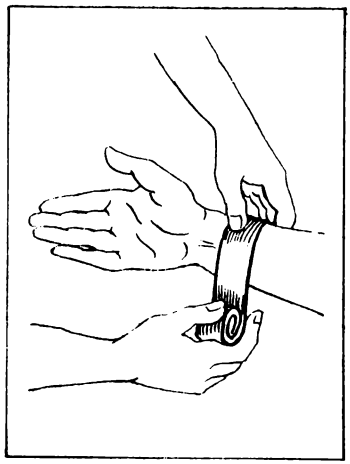


Fig. 21. Spiral bandage

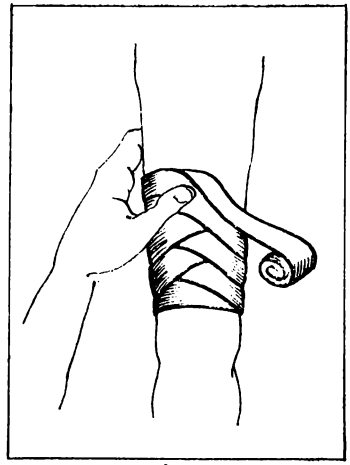


Fig. 22. Spiral bandage with reverses

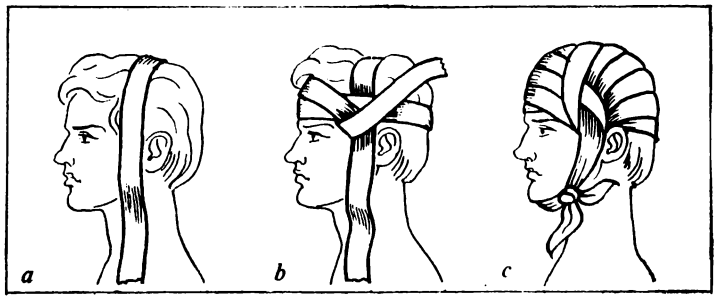



Fig. 23. Stages of application of bandage on the head (capeline bandage) (*a*, *b*, *c*)

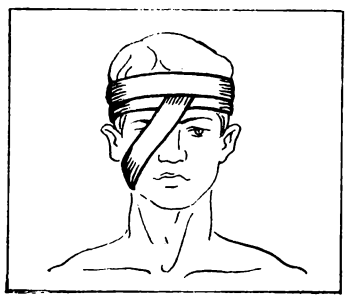


Fig. 24. Bandage for the right eye

Fig. 25. Trefoil bandage

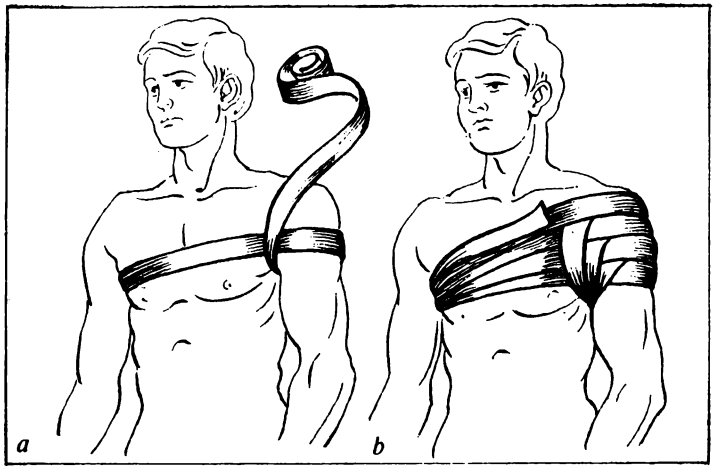



**Fig. 26.** Spica for the shoulder joint (*a*, *b*)

*Bandage for the right eye.* A roller bandage is put in position by making circular turns around the head, right to the left, in an anti-clockwise direction, then passed obliquely over the back of the head, brought out to the front under the right ear and up over the right eye (Fig. 24). Turns are passed alternatively over the eye and round the head.

*Bandage for the left eye.* It is more convenient with wounds of the left eye to apply the bandage from left to right, passing it back to the front under the left ear and then across the cheek to cover the wounded eye. Oblique turns covering the eye are alternated with circular ones.

A *trefoil bandage* can be used to cover the side of the face or an ear, or to support an injured jaw. Two or three turns of the end are passed round the head. The bandage is passed obliquely behind the head and brought out on the other side under the lower jaw; several vertical spirals are then made over the top of the head and the bandage brought over the back of the head to the front. After several circular turns around the head it is secured (see Fig. 25).

A *bandage on the neck* should be loose without unnecessary circles that would restrict breathing. A figure-of-eight bandage is most convenient for bandaging

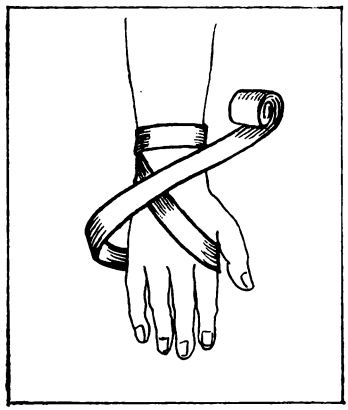


Fig. 27. A figure-of-eight bandage to the back of the wrist

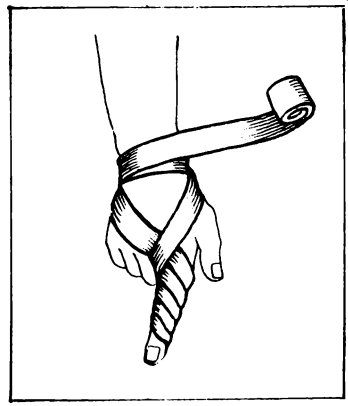


Fig. 28. Spiral bandage for the finger

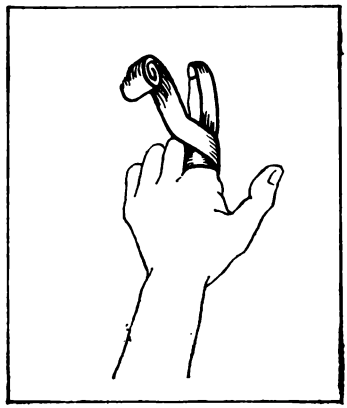


Fig. 29. Bandage for the tip of the finger

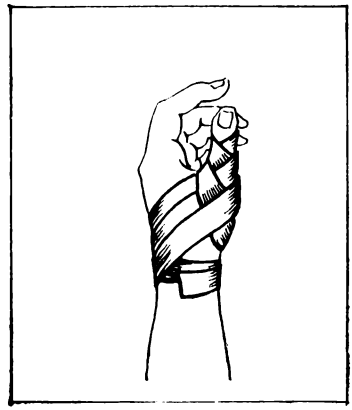


Fig. 30. Spica for the thumb

the back of the neck and head. It is fixed by circles round the head, passed obliquely over the back of the head, passing down to the front of the neck, then round the neck, returning obliquely over the forehead and again round the back of the head.

**Bandages for the upper limbs.** A *spica bandage* is used on the region of the shoulder and the humerus. Spica for the shoulder is applied as follows: the bandage is passed from healthy side of the armpit to the anterior sur-

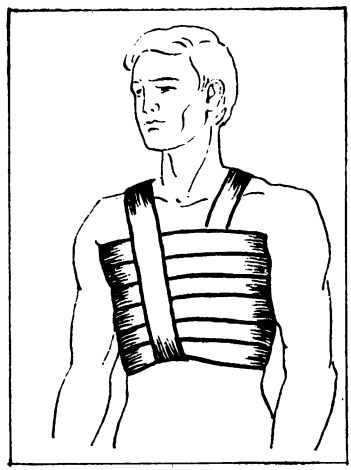


Fig. 31. Spiral bandage for the chest

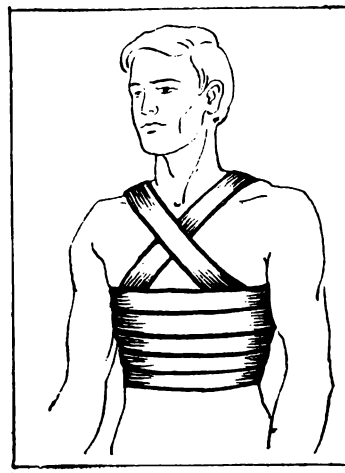


Fig. 32. Cruciform bandage for the chest

face of the chest and the external surface of the wounded shoulder, turned around front to back, brought out from the armpit forward, again round the shoulder but now the bandage is passed on the back round the chest: the bandage's turn is applied somewhat higher than the preceding one covering it by half. The turns are repeated until the whole shoulder joint and the part over it are covered and the end of the bandage is pinned on the chest (Fig. 26).

A *figure-of-eight bandage to the back of the wrist* is begun with circular fixing turns above the wrist joint. The bandage is then passed obliquely down on the back of the wrist and to the palm, round the wrist at the base of fingers and then again to the wrist back, over the carpus, to the base of the little finger, crossing the preceding turn, then obliquely to top and again round the wrist (Fig. 27).

The *bandaging of fingers* starts with circular turns around the wrist, then the bandage passes obliquely down the back of the hand to the tip of the finger. Spirals are wound round the finger to its base, returning again over the back of the hand to the wrist (Fig. 28). This method can be used to bandage all fingers in turn. On the left hand bandaging is begun from the little fin-

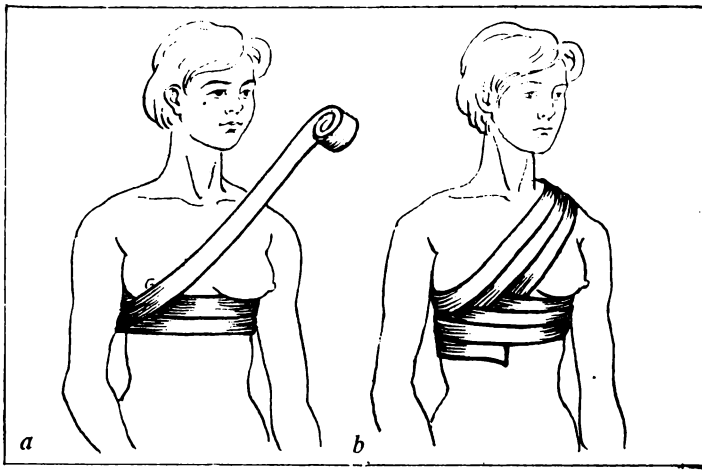



**Fig. 33.** Bandage for the breast (*a*, *b*)

ger and on the right from the thumb. When the *tip of a finger* has to be bandaged, a roller bandage is laid along the front of the finger, from the palm of the hand, turned over the tip, and returned so as to cover the lateral surface of the finger; the finger is then covered by spirals beginning from the base (Fig. 29).

The *thumb is bandaged* by a spica starting with circular turns around the wrist, passing down the back of the hand to the point of the thumb, then returning to the wrist over the back of the thumb in a spiral. More spirals are made along the thumb until it is completely covered (Fig. 30).

When the hand and four fingers must be bandaged rapidly, leaving the thumb free, a circular turn is made around the wrist, then a reverse spiral is passed down the back of the hand, turned over the tips of the fingers to the palm, returning to the back of the hand. The hand is covered with spirals by making several successive turns and the bandage is fixed on the wrist. A hand can also be bandaged by a figure-of-eight bandage.

**Bandaging of the chest.** *Spiral bandage for the chest.* A bandage about one metre long is laid over the right or left shoulder and left to hang free. Several turns of a roller bandage are then wound around the chest from bottom to top and the end is fixed. The free end of the

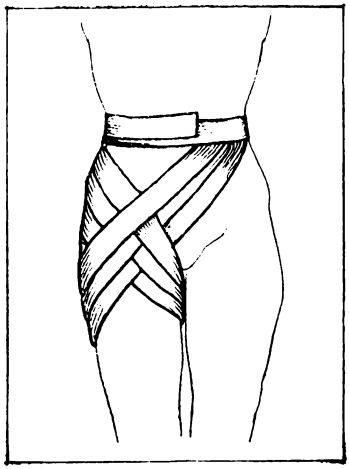


Fig. 34. Spica for the groin

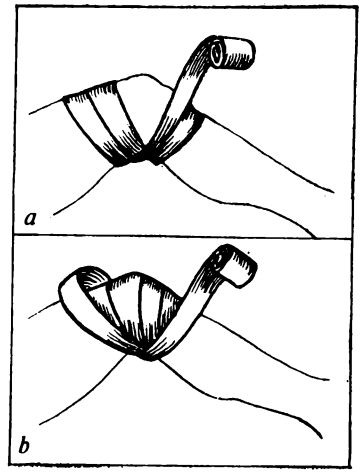



Fig. 35. Spica for the knee joint (*a*, *b*)

first bandage at the front is brought over the other shoulder and tied to the other free end at the back (Fig. 31).

A *cruciform bandage for the chest* starts with circular turns of a roller bandage around the lower part of the chest. Then a spiral is passed right to left over the left shoulder, across the back to the right shoulder, then down across the front under the left armpit and to the left shoulder. The bandage is fixed round the chest (Fig. 32).

**Bandaging to support the breasts.** For the right breast turns of the bandage are made obliquely from right to left round and below the breast. The bandage is then passed upward from right to left, laid over the shoulder on the sound side and brought obliquely round the back down to the right armpit; the bandage is then wound round the chest covering the lower part of the breast and fixing the preceding turn. It is then passed upward again lifting the breast and taken across the chest a little higher than the previous turn, passed over the shoulder. Several more turns are made, each a little higher than the others (Fig. 33).

**Bandaging of the abdomen and groin.** To cover a wound on the upper and middle abdomen a spiral bandage is convenient, but on the lower abdomen, especially in

the pelvic region, such a bandage does not hold well and may slip; it should therefore be combined with a spica bandage covering the groin and buttocks and the adjoining parts of the thigh and hips. The bandage can be applied in different ways, depending on where its turns will cross (in front, at the back, or at the side). Figure 34 illustrates a spica bandage for the groin. The bandage is fixed round the abdomen by spirals and is then passed from back to front, left to right, across the groin inside the thigh, taken up the front of the thigh, round the hips (pelvis) and down again to the groin. The bandage may be applied as an ascending or descending spica, depending on where it is turned: higher on the groin, or lower on the thigh. It is fixed by circular turns round the waist.

**Bandages for the legs.** The thigh is bandaged in the same manner as the forearm and shoulder. On the upper part of the thigh it can be fixed by passing a spica round the pelvis. The shin is bandaged by a *spiral bandage with reverses* passing down below to the joint. *Convergent and divergent reverse-spiral bandages* (spica) are used on the hinge joints, usually for the knee and, in case of the upper limbs, to elbow joints.

A *convergent spica* on the knee starts with circular turns across the knee cap, each successive turn passing higher and lower than the preceding ones, crossing in the hollow at the back of the knee (Fig. 35). A *divergent spica* starts with circular turns above and below the knee joint. The turns gradually approach the centre completely covering the knee.

A *reverse-spiral bandage* is convenient for round parts of the body. It is also used to bandage the stump of an amputation. The bandage is fixed round the thigh in the transverse direction; it is then reversed and brought down along the front of the thigh over the stump to the back (Fig. 36). On reaching the transverse turns the bandage is again reversed and a circular fixing turn made. These transverse and longitudinal turns are repeated until the stump has been completely covered.

The *heel* can be bandaged by a spica either convergent or divergent. Bandaging begins at the protuberance of the heel with subsequent turns running higher and lower than the first, partly overlapping them (Fig. 37). These turns are fixed by an oblique turn across the sole.

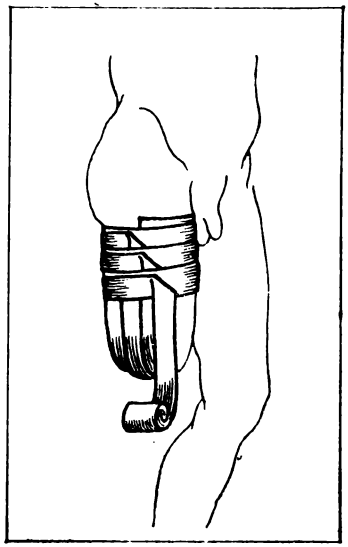


Fig. 36. Reverse bandage for the stump of the hip

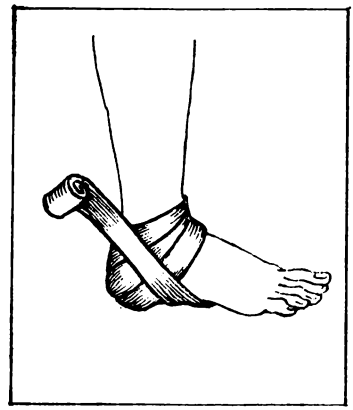


Fig. 37. Bandage for the heel

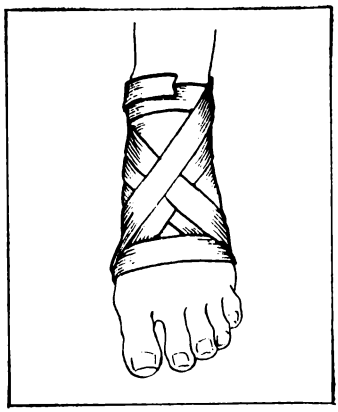


Fig. 38. Bandage for the ankle

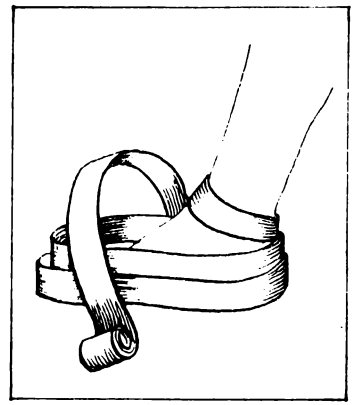


Fig. 39. Bandage for the foot

The *ankle* is bandaged by a figure-of-eight if the heel has to be left uncovered. Bandaging starts with circular turns higher than the ankle bone; the roller bandage is then crossed obliquely over the instep and under the

sole, circling up round the back of the lower leg above the ankle bone. The circles are repeated in a figure-of-eight (Fig. 38). The bandage is fixed by circular turns above the ankle bone.

When the *whole foot* has to be covered, bandaging begins with simple spirals above the ankle bone; the bandage is passed loosely several times longitudinally from heel to big toe, then simple spirals are made round the foot beginning with the toes (Fig. 39).

Small dressings can be fixed by sticking them to the skin instead of bandages in places where roller or triangular bandages do not hold well or when it takes much time to apply them. The strips of adhesive plaster used to fix bandages are cut so as to protrude 5 or 6 cm beyond the edges of the dressing.

## FIRST AID IN MINOR INJURIES

Minor injuries (cuts, punctures, abrasions, scratches, splinters) are frequent in everyday life. In themselves they are not dangerous and do not cause loss of working ability but when first aid is not properly rendered they can be complicated by purulent inflammation.

Any break in the skin, even in minor injury, should be painted immediately with a 5 per cent iodine tincture and covered with an aseptic bandage. If skin and wound are contaminated, the skin around the wound should be wiped with 0.5 per cent ammonium hydroxide and the wound with 3 per cent hydrogen peroxide. When the edges of the wound are smooth and even but the wound is wider than 0.5 cm its edges should be brought together. For that purpose a piece of adhesive plaster shorter than the wound is cut from a strip and one end is stuck across one edge of the wound to the skin, the opposite edge of the wound is brought close and fixed by the other end of the plaster. The plaster should not wholly cover the wound, and its ends should be left uncovered. An aseptic bandage is then applied to the wound over the plaster. Minor wounds and abrasions are covered by collodion or a special glue.

It is desirable to cover punctured wounds with a spirit bandage.

With contusion of the fingers or toes there is often bleeding beneath the nails that later can suppurate and

cause acute inflammation. To prevent this complication it is necessary for a doctor to release the blood accumulated under the nail and apply a spirit bandage. The procedure is simple and does not require anaesthesia. When foreign bodies (clearly visible metallic needles, filings or chips, splinters of wood, etc.) penetrate the skin they should be removed by tweezers, the wound painted with iodine tincture and a spirit bandage applied.

## SNAKE BITES

Bites by poisonous snakes are injuries that seriously endanger life. More than four-fifths of all cases are registered in Asia, Africa, and South America. The number of victims in India alone is 100 000 annually.

Poisonous snakes have sacs of venom above their upper fangs. When they bite venom pressed into the wound enters the blood vessels, and is carried throughout the body with blood stream.

Snake venom contains various poisonous substances some of which affect the nervous system (the venom of coral and sea snakes and certain species of rattlesnake), others inhibit the function of blood vessels and heart and impair blood clotting. The first signs of snake poisoning are therefore quite different. General intoxication shows within 30 to 90 minutes after the bite. The victim may develop cardiogenic shock or collapse with a drop in blood pressure and stoppage of breathing because of paralysis of the respiratory centre and muscles.

Local signs of bites by the coral and sea snakes are two small points on a mildly swollen skin. The bite by a viper (adder or rattlesnake) causes pain, a burning sensation at the site of the bite, reddening and swelling of the skin, much bleeding and thrombosis of the veins in the whole limb as well as at the site of the bite.

*First aid* consists in rapid, vigorous sucking out of the contents of the wound for 15 minutes. Such sucking of the wound by mouth for the first six minutes after a bite, it should be noted, ensures that about three-quarters of the venom is sucked out. If the wound has dried it should be opened by collecting the skin into a fold and pressing, the content of the bite sucked by the mouth or by means of a breast pump or rubber bulb. The ven-

om getting in the sucker's mouth is rapidly dissolved and rendered harmless, and the amount of venom secreted by the snake is not dangerous even when the helper has scratches or breaks on the lips and lining of the mouth.

When the venom has been sucked out the bite is painted with iodine tincture or surgical spirit, or brilliant green. It is advisable to immobilize the limb so as to lessen the flow of venom-containing lymph from the affected part of the body. Copious beverages are recommended (tea, coffee, broth or bouillon). Alcohol in any form is contraindicated. It is categorically forbidden to tie a tourniquet round the limb, or to cauterize the bites with gunpowder, acids, alkalis, boiling oil, etc.

After first aid has been rendered the victim should be taken rapidly to the nearest medical point where antivenom serum is available (antigursa, antiefa, anticobra, and so on).

Individual prophylaxis against snake bites consists in wearing high leather boots and closely woven clothing and carefully inspecting camping sites and lodgings.

Snakes usually do not attack people, it should be remembered, and only defend themselves. Those who get bitten are usually people who try to catch or kill a poisonous snake.

## CLOSED INJURIES

Closed traumas are mechanical injuries in which the skin and mucous membranes are not broken. They include contusions of various parts of the body (and the skull and brain), strained ligaments, dislocations, subcutaneous rupture of the muscles, internal organs of the chest and abdomen, and bone fractures.

**Bruises and contusions** may be caused by a blow from a blunt object or by falling. The signs include pain at the site of the injury and the development of a bruise which becomes bluish in a few days.

*First aid.* In order to lessen the pain and to prevent bleeding the contused area should be immobilized, raised and cooled by applying an ice bag or a cold compress. The cold contracts the blood vessels and reduces bleeding. Two or three days after the bruise warmth should be applied to accelerate resolution of the effused blood (hot compresses, local warm baths).

A hot compress (fomentation) is made as follows: a folded pad of cloth is soaked in water, an 8 per cent solution of surgical spirit or camphor oil, wrung out and applied to the skin. An oilskin or waxed paper of a larger size (two or three centimetres larger than the compress) is laid over it and the whole is covered by a thick layer of cotton wool and secured with a roller bandage. The compress is left for six to eight hours, in which time the moist layer dries. After the compress is removed the skin is wiped with alcohol.

**Sprains of ligaments** are frequent. An awkward movement wrenches a joint or a slip overextends a joint, which causes some degree of tearing of the joint capsule or ligaments. Pain and swelling develop around the joint but its outlines are generally not noticeably altered. The victim can use his limb, but with difficulty: put weight on the foot or move the painful arm. After a few days the skin becomes black and blue.

*First aid.* The affected limb should be immobilized (an arm put in a sling made from a triangular bandage and affected ankle tightly bandaged). After two or three days treatment is begun (hot compresses, local warm baths and massage).

A **dislocation** is a more serious injury attended with rupture of the joint capsule and displacement of the joint surfaces of the articulated bones.

*First aid.* A fixing bandage or a splint is applied and the patient sent to hospital for the dislocation to be reset.

**Fractures** may be open or closed. Open fractures in which not only the bone but also the skin are damaged are most dangerous. Germs can get into the wound formed by the break in the skin and cause suppuration, gas gangrene, or tetanus. In closed fractures the outer coverings (skin and mucous membranes) are intact and prevent the entry of germs.

The signs of fractures of the long tubular bones include pain, haemorrhage, distortion of the injured part of the arm or leg, abnormal mobility in a place where there should be none, crackling, swelling, and inability to make any movement.

The fragments of the bone may be displaced to a varying degree in length, width, or at an angle to each other causing some deformation of the limb.

The destruction of the bones and surrounding soft tissues is particularly extensive in gun-shot fractures. Fragments damage the surrounding tissues, nerves and blood vessels. The damaged muscles impregnated with blood become a favourable medium for the growth of harmful microbes that have got into the wound together with soil and bits of clothing.

*First aid.* The limb affected must be immobilized. This is especially important during transportation of the patient. The bone fragments should be tied so that they cannot move. The rules for immobilizing fractures are given in the section 'Injuries to the Arms and Legs'. If they are not observed grave complications can develop menacing the patient's life.

## INJURIES TO THE HEAD AND FACE

Wounds of the head and face are attended with quite profuse bleeding because of the widely ramified network of blood vessels in this area.

A pressure bandage is applied to stop bleeding. With very profuse bleeding from the temple or the parietal area, the temporal artery is pressed at the site of the wound until a tight pressure bandage is applied.

With bleeding from a damaged nose the patient is asked to remain silent and not to blow his nose; ice, a bag of cold water, or cold compresses should be applied to the nose and back of the head. Small balls of cotton wool should be inserted into the nostrils and the wings of the nose strongly pressed with the fingers as high up as possible. The head should be bent slightly forward so that the blood does not run into the nasopharynx but into the front of the nasal cavity to clot there.

A **closed craniocerebral trauma** is the most common type of injury to the skull and brain. It is caused by a heavy blow on the head, strong jerkings, or throwing back of the body.

There are often no visible local signs of the injury, or they are displayed by superficial abrasions, bruising of the face or scalp. But that does not exclude injury to the brain inside the skull, which may have suffered contusion or concussion.

Injury disturbs circulation of the blood and fluid in the brain cavities. Bleedings of various degrees and lo-

calization occur in the brain matter and it swells. In mild cases these changes inhibit functioning of the cerebral cortex; in severe cases they sharply impair vitally important functions of the organism, breathing and circulation.

With **concussion of the brain** consciousness is lost at the moment of the trauma for either a brief period (few minutes) or several hours. In addition, there is vomiting, a slowing of the pulse (sometimes a quickening), and loss of memory of events preceding the trauma. On coming to the patient complains of general weakness and headache, and does not remember anything connected with the trauma.

**Contusion of the brain** has a severe course though initially it resembles the picture of concussion. Later, the morbid symptoms increase rather than disappear. Consciousness may not be lost immediately but one or two hours after the injury because blood escaping from the damaged vessels compresses the brain. Paralysis and convulsive spasms of the muscles occur.

Fractures of bones of the cranium, and particularly of those of the base of the skull, are even more dangerous. They may be open and closed. Fragments of bone often get pressed into the cranial cavity damaging the dura mater (the thick membrane forming the outer envelope of the brain), brain matter, and vessels.

In most cases with fractures of the skull the patient loses consciousness at the time of the injury, and there are vomiting, a decelerated pulse, and other signs typical of concussion of the brain. In addition, certain parts of the brain portions lose their function, which leads to development of paralysis of the limbs, disturbances of eye movements, distortion of the face, and speech disorders.

The signs of fracture of the base of the skull include deep loss of consciousness, flow of blood and sometimes spinal fluid from the nose, ear, or mouth, and haemorrhages around the eyes.

Only a doctor can establish the degree of damage to the skull.

*First aid in injuries to the brain and skull.* When the victim is unconscious and his breathing is difficult because of retraction of the tongue or filling of the mouth and nasal cavity with vomit, the mouth should be cleaned,

the lower jaw pulled forward and the tongue clamped. The patient should be laid on his side, an ice bag or a cold compress put on his head, and taken carefully to hospital, avoiding jolting.

With a wound of the head the hair around it is shaved or cut short, the skin smeared with a disinfectant, and a sterile bandage applied.

**Dislocation of the lower jaw** occurs when the chin is struck or the mouth has been opened too wide. The signs of dislocation are quite typical: pain, inability to close the mouth, forward displacement of the chin, and sagging in the area of the capitellum of the jaw on the affected side. The patient must be sent immediately to a doctor. If that is not quickly possible, he must be helped.

*First aid.* The victim is seated on a low stool, the person rendering first aid stands behind, holds his head and lower jaw firm, inserting his thumbs into the victim's mouth so that they bear on the masticatory surface of the molars, and depresses the victim's lower jaw downward by slow, strong pressure. In a few moments the dislocated jaw moves into place and closes.

**Fractures of the jaws** may be open and closed. In gunshot wounds of the lower jaw there is great damage. The big bleeding wound and deformed face produce a false impression that the injured person's state is particularly grave and hopeless.

*First aid.* Bleeding is stopped by applying a pressure bandage. The bits of the jaw should be fixed temporarily by standard or improvised splints.

Closed fractures of the upper jaw are recognized from the deformity of the face, painful swelling, or uneven contures of the facial bones, found by palpation.

When the upper jaw is intact and enough of teeth remain in it and the lower jaw, the broken parts of the lower jaw are set up in the correct position and tied by a rigid sling, or a gauze bandage. It is advisable to apply gauze roller bandages parallel to the edge of the lower jaw.

The extensive damage in gun-shot wounds of the jaws may cause a flow of blood into the trachea, retraction of the tongue, and disturbances of breathing. The retracted tongue of an unconscious patient should be pulled out, pinched with a safety pin taken from the first-aid kit and tied with a bandage.

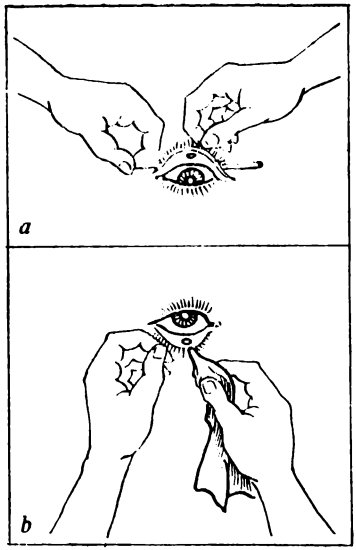



Fig. 40. (*a*), eversion of the eyelid and (*b*), removal of a foreign body

The injured person should be transported with his head turned sideways, with the wound uppermost.

The most common **eye injuries** are burns and minor injuries with penetration of the eyeball by foreign bodies.

**Foreign bodies** penetrating the eye cause irritation, pain, and watering. If the foreign body (particle of sand, soot or small insect) has not penetrated the sclera or conjunctiva, it can be removed with someone's help. For this purpose the eyelids should be pulled forward and sometimes turned inside out. With the upper eyelid this is done by pulling it forward and downward and pressing the index finger on its base at the top so that the lid is bent over inside out. The mucous membrane of the lower lid is inspected by pulling it downward and pressing the finger against its base.

A foreign body swimming freely in the conjunctival sac is removed with the tip of a clean handkerchief or gauze (Fig. 40).

When the eye is heavily affected by dust it is washed with water.

The eye is also washed when alkaline substances (or acids) get into it. Wounds and burns are covered by an aseptic bandage.

## CHEST INJURIES

Fractures of the ribs are most common in chest injuries. They are caused by falling down, a blow, or compression of the chest.

*Signs of a fracture* are pain on the injured side during breathing, which becomes stronger when pressure is

exerted on the affected area or the chest is pressed on the front or side.

The bits of the broken ribs can damage the tissue of the lung. In such cases bouts of coughing begin, and sputum mixed with blood is spat out; more rarely air from the pleural cavity gets under the skin through the damaged pleura causing what is called subcutaneous emphysema. The air spreads in the subcutaneous tissue of the chest, and passes up the neck and face, causing marked thickening of the subcutaneous tissue and bloating of the face.

*First aid.* It is necessary to apply an immobilizing bandage. Several bands of 5-cm adhesive plaster are fixed along the course of the broken rib from the spine to the breast bone during exhalation. The plaster is covered by an ordinary roller bandage or the chest wrapped in a towel and its end stitched.

When necessary an analgesic tablet is given to relieve the pain.

**Chest wounds** penetrating the pleural cavity are encountered in peacetime as knife wounds or stabbing. Normally a negative pressure is constantly maintained inside the chest and there is no air between the lungs and the walls of the pleural cavity. When the intercostal muscles are tensed the ribs are raised and the diaphragm is flattened, the chest cavity widens, and conditions are created for sucking air in through the windpipe and bronchi into the lungs, which are expanded. The chest cavity widens and inhalation occurs. When the chest muscles are relaxed, the ribs are lowered, air is pressed out of the lungs, and exhalation occurs.

When there is wound of the chest wall or the lung the hermetic state of the pleural cavity on the affected side is impaired, the air passes through the wound in the chest wall or the lung into the pleural cavity thus causing collapse of the lung and cessation of breathing in it. Passage of air into the pleural cavity is called pneumothorax. When the wound is not big and air passes into the pleural cavity in small amount, the lung collapses but is somewhat involved in breathing. When the edges of the wound have adhered and no air comes into the pleural cavity, a condition develops known as closed pneumothorax.

The picture is quite different with a gaping chest

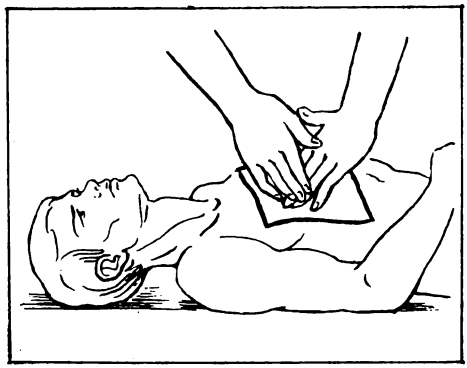


Fig. 41. Application of the occlusive bandage in open pneumothorax

wound. The lung on the affected side collapses and is not involved in breathing. During respiratory movements of the chest air freely passes in and out through the wound in the pleural cavity. Breach of its hermetic state and exclusion of the lung from breathing create conditions for a marked displacement of the mediastinal organs to the wounded side, cause a swinging of the mediastinum during the breathing of the healthy lung, kinking of the large mediastinal blood vessels, and stimulation of the nerve endings. This grave condition, known as open pneumothorax, is often complicated by shock and is dangerous.

*First aid.* Entry of air into the pleural cavity must be stopped immediately. A hermetic bandage is applied, for which it is better and more convenient to use the rubberized envelope of a bandage pack. Its inner (sterile) surface is applied to the wound so that it more than covers the wound and surrounding skin (Fig. 41). To ensure full adherence of the bandage, the skin around the wound is smeared with vaseline or a special glue, and the patch bandaged by round turns of roller bandage. If a first-aid pack is not available a tight bandage is applied. The massive bandage should cover the wound tightly to prevent air from passing into the pleural cavity during breathing (an occlusive bandage). It is best to transport the injured person in a semi-sitting position with the upper part of the body raised. With profuse

spitting of blood caused by a wound in the lung, the victim is advised not to talk, to breathe calmly, and to keep from coughing if possible. An ice bag or cold compresses are applied to the chest and the patient is given salty cold water to drink or pieces of ice to suck.

## INJURY TO THE ABDOMINAL ORGANS

Contusions of the abdominal wall may be accompanied with injury to the internal abdominal organs, such as rupture of the liver, spleen, intestine, or stomach. Internal bleeding is dangerous and develops with rupture of the liver and spleen, and of the blood vessels of the mesentery.

Damage to the walls of the hollow organs (stomach, intestine) causes the development of grave complication, i.e. inflammation of the peritoneum (peritonitis) because the contents of the gastro-intestinal tract contaminated with germs are discharged into the abdominal cavity. Bile discharged into the abdominal cavity (with wounds of the liver and especially of the major bile ducts) causes dangerous biliary peritonitis.

The kidneys and bladder are located outside the abdominal cavity, but when they are extensively ruptured blood and urine may accumulate in the retroperitoneum, soak the soft tissues of the pelvis, and penetrate into the abdominal cavity, causing peritonitis.

Damage to the internal organs of the abdominal cavity takes a grave course and is very often complicated by traumatic shock.

Signs of the damage to the internal organs include severe pain in the belly, which develops from the effect of the injuring force (as when a person falls and strikes a hard object with his abdomen, or is punched or kicked in the stomach, and so on).

The victim generally lies on his side with his legs pulled up and moans. The skin and visible mucous membranes are pale. The anterior abdominal wall is sharply tensed and is painful to palpation. The pulse is quickened and weak. With intra-abdominal bleeding the skin is particularly pale, and the tongue dry, the patient is thirsty, yawns, and has a feeling of dimness in the eyes, nausea, and vomits. Sometimes he feels worse when lying down and tries to rise and to sit. When laid down he again sits

up, a condition that indicates damage to the internal organs.

When there is a wound in the abdominal wall it is necessary to find whether it penetrates to the abdominal cavity and whether the internal organs are damaged.

An absolute sign of a penetrating wound is protrusion of an intestinal loop or the peritoneum through the wound. In other cases a penetrating wound is diagnosed from indirect findings, the location of the inlet and outlet of the wound, and after consideration all the signs mentioned above that are typical of closed injuries to the abdominal organs. There is often bloody urine with damage to the kidneys or bladder.

*First aid.* A sterile bandage is applied immediately to the abdominal wound. An intestinal loop or bit of the peritoneum protruding through the wound should not be pushed back but covered with a bandage, using several large bandage packs or a clean towel or sheet for the purpose. A person with damaged internal organs is not permitted food or drink. He is laid on a stretcher with his legs bent. Cold compresses are applied to the abdomen. The victim should be transported as soon as possible, taking all precautions, to a hospital where an emergency operation can be performed.

## INJURIES TO THE SPINE

Injuries to the spine include fractures and dislocations of the vertebrae, and gun-shot wounds. They are dangerous because the spinal column contains the spinal cord, which can be compressed by bone fragments, displaced by an injury caused by the shell splinter, partially or fully crushed.

With injury to the spinal cord sensitivity is lost and the lower part of the trunk is paralysed. The function of the pelvic organs is impaired (urination and defaecation are delayed). Bedsores develop in the sacrum, heels and in the area of the shoulder blades, general infection of the blood (septicaemia) begins which finally results in disability or death. Fractures of the neck vertebrae often occur when the head strikes the ground or some other hard object (for instance when diving into an unfamiliar swimming place); in such cases, in addition

to the injury to the spine, the person may lose consciousness and drown.

*First aid.* The injured person should be lifted and moved in such a way as to avoid bending, twisting or displacement of the damaged vertebrae. With any careless movement bits of bone may be displaced and cause additional injury to the spinal cord. The injured person should be laid on a hard surface; no attempt should be made to turn him or to sit him up. To carry the victim it is convenient to place a board on the stretcher so as to provide a firm surface. The board or other solid object (sheet of plywood) should be covered by a blanket folded twice.

The victim may be shifted onto a stretcher by means of a plank or board pushed under his back. In exceptional cases, he should be lifted by three persons, one supporting his head, one with his hands under the shoulder blades, and the third supporting the buttocks and knees in order to prevent sagging of the spine. When no firm surface is available the victim is carried face down on a stretcher.

With broken neck vertebrae a massive bandage of cotton wool and gauze may be applied as a collar. If the layer of cotton wool is sufficiently thick the bandage prevents bending of the head and provides some immobilization. Compression of the neck and chest should be avoided during bandaging. The victim is taken gently and carefully to hospital.

## FRACTURES OF THE PELVIS

Fractures of the pelvis are grave injuries. They occur with strong compression of the pelvis between moving mechanisms, in collisions with a vehicle, and in falling from a height. The fractures are often accompanied with consequent damage to the internal organs of the pelvis (bladder, urethra, and intestines).

It is difficult to recognize these fractures because of the deep location of the pelvic bones. The main signs of damage are pain at the point of the fracture and inability to sit or to stand. When in a reclining position, the victim cannot raise an outstretched leg. Pressure on the pubic bones or side compression of the pelvis causes strong pain. Bloody urine and difficult urination

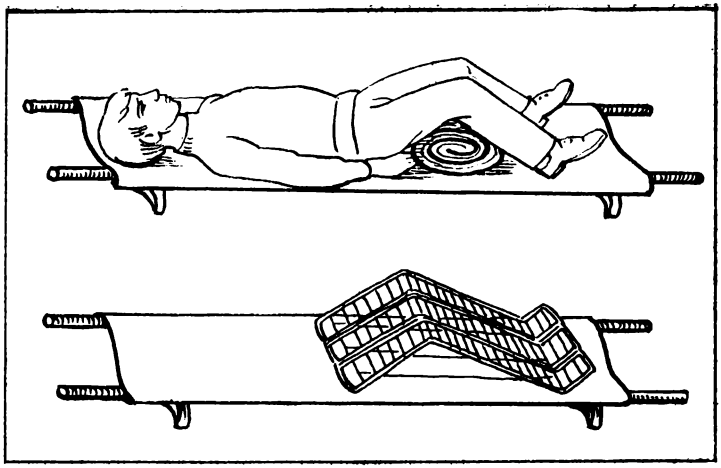


Fig. 42. Transportation of a person with a fracture of the pelvis

with rupture of the urinary canal or bladder sometimes indicate an injury to the pelvic bones.

In order to prevent possible later displacement of fragments of bone and damage to the internal organs by their sharp edges the pelvis should be bound with a towel at the level of the iliac bones.

The victim is placed on a rigid stretcher covered by a folded blanket or an overcoat. A rigid, unbending surface is provided in the same way as for immobilizing fractures of the spine by putting a wooden board on the canvas of the stretcher. The victim is put in a 'frog' position as shown in Fig. 42, lying on his back with his legs parted a little and bent at the knees. A bolster (cushion, folded blanket, folded clothing) 25 to 30 cm high is placed under the knees and a pad of cotton wool inserted between the knees to separate them slightly. The lower parts of the hips and both ankles are tied with a roller bandage and the supporting bolster under the knees or splints are fastened to the stretcher.

## INJURIES TO THE ARMS AND LEGS

Dislocations of the shoulder are a frequent injury of the arms. Dislocation is recognized from the forced position of the arm and the altered contours of the joint.

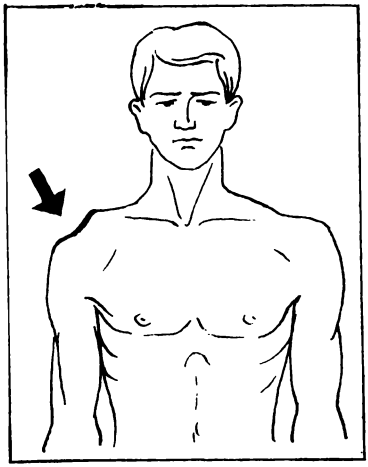


Fig. 43. Dislocation of the right shoulder

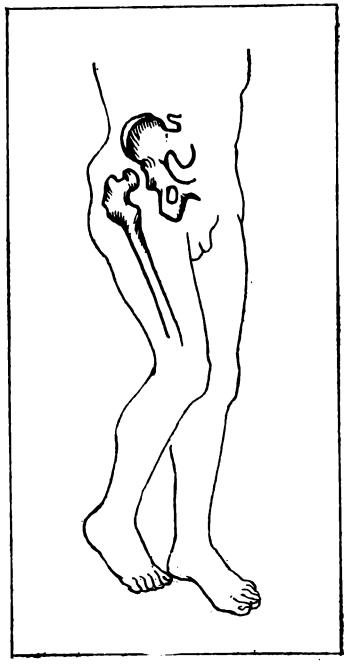


Fig. 44. Dislocation of the right hip

The injured person keeps his arm bent at the elbow and a little to one side of the trunk.

The shape of the shoulder is distorted because the head of the humerus is displaced forward and down in relation to the socket of the joint, and a gap forms in its place. Attempts to move the joint cause sharp pain and the shoulder 'springs' (Fig. 43).

**Dislocations of the elbow** are less frequent. There is marked deformation of the elbow and thrust backward of the point of the elbow; movements are greatly restricted and painful.

*First aid.* The injured arm should be supported by a triangular bandage and the patient taken promptly to hospital. Do not attempt to reduce the dislocation.

**Dislocation of the hip** is caused by rather strong force. The limb seems to be shortened because the hip is displaced upward (Fig. 44). No one without medical training can determine exactly whether the hip is dislocated or the neck of the thigh bone is fractured, which is more common. When the neck is fractured the leg

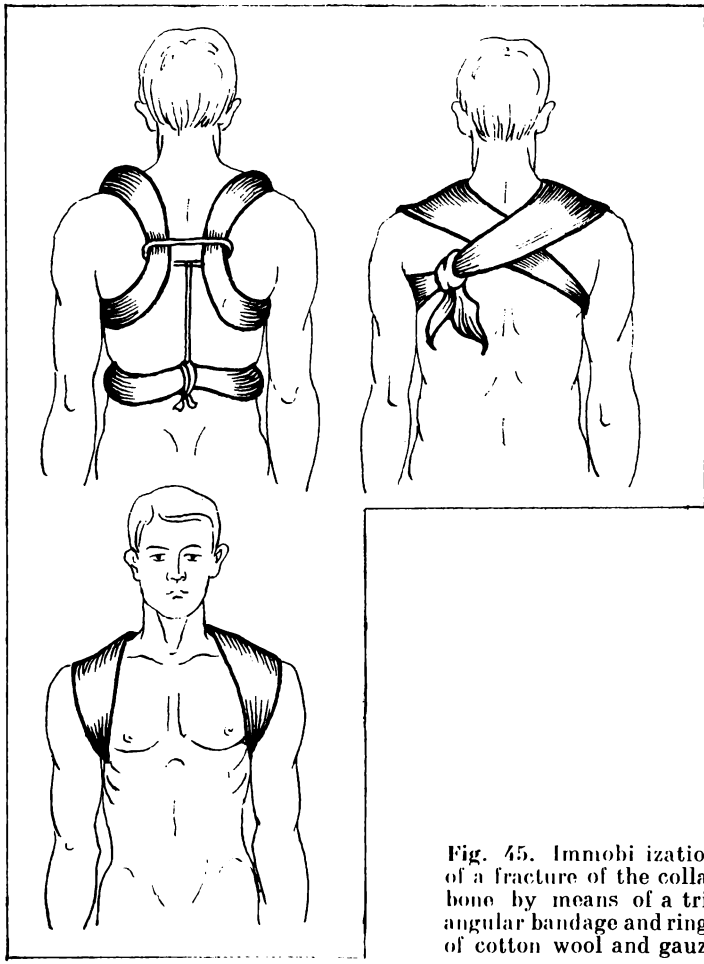


Fig. 45. Immobi ization of a fracture of the collar bone by means of a triangular bandage and rings of cotton wool and gauze

is not turned inward, as it happens in dislocation, but outward and the mobility of the hip joint is much less restricted than in dislocation.

The injured person should be transported on a stretcher with the limb immobilized.

**Dislocations of the knee** are rare. They are recognized by a sharply pronounced bayonet-like deformation of the knee with the knee cap protruding at an angle to the axis of the limb. There are marked swelling and haem-

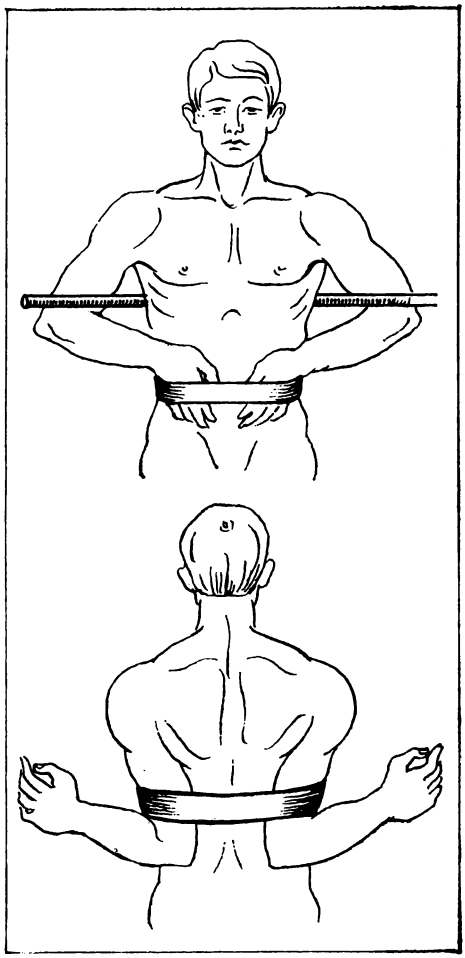


Fig. 46. Immobilization of a fracture of the collar bone by means of a stick

orrhage around the joint because soft tissues are ruptured and the blood vessels damaged.

*First aid.* A splint is applied to the leg from the toes to the groin and the injured person taken to hospital.

**Fracture of the collar bone** occurs when the bone is struck directly, or when a person falls down sideways. Pain, deformation owing to displacement of the fragments, and haemorrhage develop at the site of the fracture. Palpation reveals mobility of the fragments of

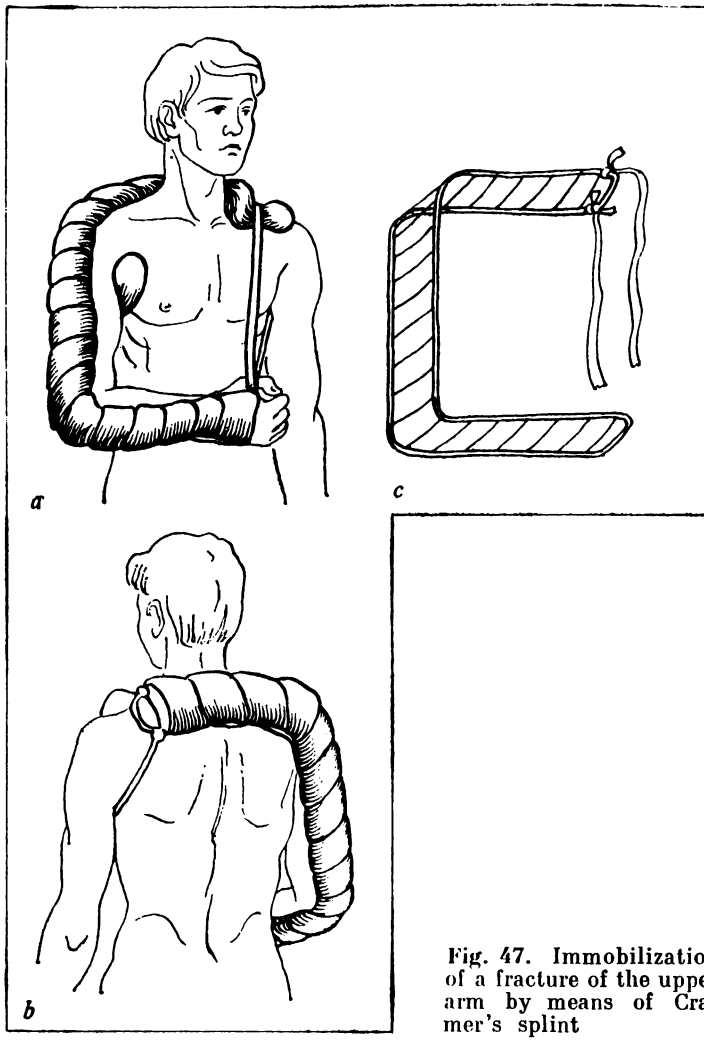



Fig. 47. Immobilization of a fracture of the upper arm by means of Cramer's splint

the bone and grating at the fracture. It is impossible to move the arm.

In order to transport the injured person the fractured collar bone should be immobilized by means of rings made of gauze and cotton wool, applied in the region of the shoulders and tightened on the back by a rubber

tube (Fig. 45). The cotton wool and gauze plait from which the rings are made should be quite thick, at least 5 cm in diameter, so as to exert even, painless pressure on the shoulders. The inner diameter of the ring should be 2 or 3 cm wider than the thickness of the shoulder.

A triangular figure-of-eight bandaging can also be used to fix the fracture temporarily. The injured person is put in a sitting position and his shoulders drawn backward and secured by a triangular bandage. A pad of cotton wool and gauze is put between the shoulder blades in order to draw the shoulders back even more and to stretch the fragments of the collar bone. After the bone has been immobilized, the arm should be supported by a sling (using a triangular bandage).

Fractures of the collar bone are often supported by Desault's bandage. The shoulder is pulled back, slightly drawn, a kidney-shaped cotton-wool pad placed in the armpit, and the elbow bent at a right angle. The arm is bandaged in this position to the trunk. The trunk and shoulder are bandaged first by several turns in a clockwise direction; the bandage is then brought out from the armpit on the sound side, passed over the chest and over the affected shoulder, down the back over shoulder blade, to the elbow joint, binding it from back to front; the bandage is then passed over the forearm and under the armpit to the back, taken obliquely upward across the back, and over the affected shoulder, down along the shoulder and under the elbow to the back. The turns are repeated several times.

Fractured collar bone can be secured temporarily by means of a stick as shown in Fig. 46. The arms are bent at the elbow, drawn back and held in this position by the ends of a stick placed across the back. All the necessary manipulations should be made without exerting strong pressure, bearing in mind that major blood vessels pass beneath the collar bone and can be damaged.

A **closed fracture of the humerus (upper arm)** may occur in different parts of the bone. Active movement of the shoulder is almost impossible and acutely painful.

When the humerus is fractured in the middle the deformation is more pronounced and the limb is shortened because of the displacement of the fragments. The arm is thickened at the site of the fracture, there is ab-

normal mobility, and grating of bone fragments is heard during movements.

It is dangerous to try and move the limb to check for grating, and it is contraindicated to do so.

*First aid.* A splint or immobilizing bandage is applied, using a triangular or roller bandage, when a fracture is suspected. In fracture of the upper arm three joints must be immobilized: the shoulder, elbow, and wrist.

The main thing in rendering first aid in fractures is to immobilize the fragments of the injured bone. Splints are normally used. They may be made of any material at hand—plywood, a board, metal wire (woven into a net or ladder), and so on. The splint is so applied as to immobilize the two joints adjoining the site of the break (above and under the site of fracture). A soft padding of cotton wool or cloth is placed under the splint where the bone projects. The splint is covered with cotton wool and is wrapped with a roller bandage to reduce its pressure on the fracture, and is then bandaged to the injured arm.

Among the things that can be used for fractures of the upper arm are strips of cardboard, a stick or a branch from a bush. If nothing is available the injured arm can be supported by a triangular bandage and bandaged to the trunk, putting a ball of cotton wool in the armpit.

For transportation of the injured person a broken upper arm is best immobilized by Cramer's splint (Fig. 47), if one is available. The splint is first moulded according to a sound arm. A length equal to the forearm and hand is left at one end of the splint, which is then bent at a right angle to provide sufficient place at the angle for a soft padding to protect the elbow from the pressure of the splint. The length of the upper arm is then measured off and increased by 2 or 3 cm to allow for the thickness of the cotton wool and gauze padding. The part of the splint adjoining the shoulder is carefully modelled, bending it at an angle of 115 degrees and twisting it along the axis so that it fits snugly to the shoulder and repeats the shape of the space between the shoulder blades and ends on the opposite shoulder blade from the injured arm. The segments of the splint on the shoulder and supporting the forearm are bent into a groove, by alternately

bending the transverse wires. A curve is also made to prevent pressure on the neck.

It is convenient to bend a splint by resting it on the edge of a table. When the splint has been prepared, the shoulder is drawn slightly to one side and a kidney-shaped pad of cotton wool and gauze 15×10×5 cm is put under the armpit. The moulded splint (if not already padded) is covered with a padding of cotton wool and gauze and secured by a roller bandage. The arm bent at a right angle at the elbow is placed into the shaped splint. Two strips of bandage are tied to the end of the splint that rests on the back. The front piece of free bandage is passed over the sound shoulder and tied at the front to the inside of the lower end of the splint; the rear strip is brought down under the armpit and tied to the outside end. The neck and shoulder are padded with cotton wool and gauze. The strips of bandage need to be tightened so as to keep the arm bent at the elbow at a right angle.

The splint is then bandaged to the arm beginning at the hand, and should be firmly fixed at the shoulder. Turns of bandage are applied in a figure-of-eight passing under the armpit on the sound side. The upper end of the splint is secured so as to prevent its sliding up to the back of the injured person's head by turns passing over the shoulder to the front and around the trunk (Fig. 48).

**Fractures of the forearm.** The forearm consists of two bones—the radius and ulna whose fractures may be quite varied: isolated fractures of one bone, or combined fractures of both at one or more levels. Fracture of the radius at the wrist is most common and often happens to drivers from a blow from the starting handle when it is released during hand-starting of their engine. In order to avoid this injury the handle should be gripped on one side by all fingers without opposing the thumb.

The signs of fracture of the radius are typical: pain is felt in the lower part of the bone and there is bayonet-like deformation of the forearm because of displacement of the fragments (Fig. 49).

Two joints have to be immobilized with a broken forearm: the elbow and wrist. This is best done by Cramer's splint. The elbow of the injured arm should be bent at a right angle and the forearm turned with the palm to the trunk. Cramer's splint is bent at a right angle so

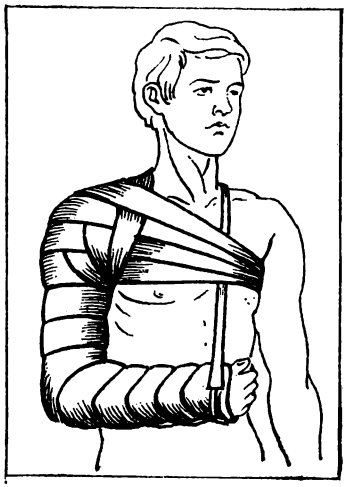


Fig. 48. Immobilization of a fracture of the upper arm

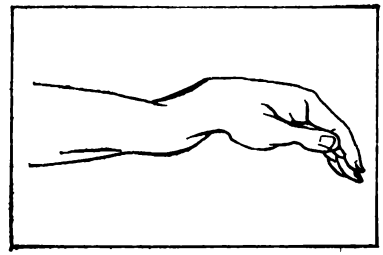


Fig. 49. Deformation of the forearm in a fracture of the radius

that the forearm and wrist lie freely on it. The transverse rods of the splint are bent to form a groove, which helps fix the forearm in the right position. A quite thick ball of cotton wool is put under the palm and bandaged to the hand. The splint is applied from the tips of the fingers to the upper third of the upper arm, bandaged, and the arm supported by a triangular bandage. When wire splints are not available cardboard or plywood can be used. The cardboard moistened in water and bent to the shape of upper arm and forearm is secured by bandage.

When the radius is broken in a typical place the forearm is immobilized by a cardboard splint from the tips of the fingers to the elbow. The hand and wrist are put in a normal position and a ball of cotton wool placed under the palm.

**Injuries to the hand** complicated by damage to its bones and joints also need to be immobilized. One must remember the important, varied functions of the hand. At rest the wrist has a slight rearward bend and the fingers are semiflexed, with the thumb to one side. It can be opposed to all other fingers, which enables the hand to grasp. When the hand is immobilized its functionally favourable position should be maintained.

**Fracture of the thigh.** The thigh bone is the biggest one in the human body. It is surrounded by the whole mass of muscles through which major blood vessels and

nerves pass. When the thigh bone is broken the surrounding soft tissues are also damaged to a varying extent.

Damage to the blood vessels is attended with profuse haemorrhage. Blood accumulates in the cavities formed by rupture of the muscles. The internal haemorrhage and strong stimulation of the damaged nerve endings often cause a general pain reaction of the organism to the trauma, i.e. shock.

Fractures of the thigh occur under the strong impact of mechanical force, as when hit by a vehicle or in a collision, falling from a height, or from a strong blow by a heavy object on the leg.

The injured person complains of strong pain at the site of the fracture and inability to put weight on the injured leg. There are distortion, abnormal mobility, and grating of the fragments rubbing together at the site of the fracture. The thigh may be shortened and bent at an angle, depending on the way the bone fragments are displaced.

*First aid.* The victim should be given anaesthetics and his leg immobilized. Immobilization considerably lessens additional damage to the tissues and is most essential in order to prevent severe complications connected with transport, the most common of which is shock. In many cases correct immobilization relieves compression of the blood vessels, improves circulation in the affected area, and so increases the damaged tissues' resistance to infection. Rest plays a big role in

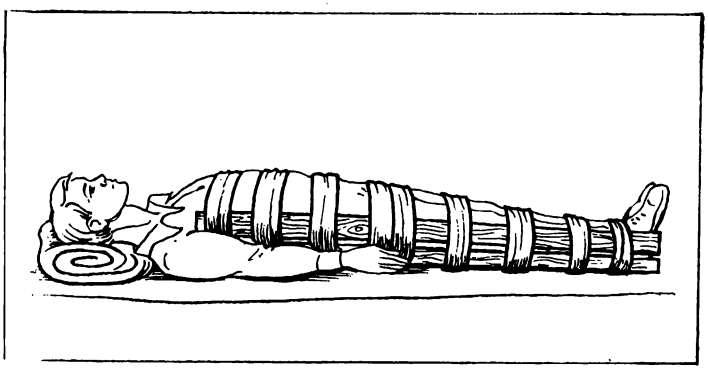


Fig. **50.** Immobilization of a broken thigh by splints

preserving the blood clots that clog the injured vessels and prevent secondary bleeding. Materials available at the site of the accident are often used to immobilize fractures of the thigh (Fig. 50).

Two splints are made of the materials available: an inner one from the groin to the heel, and an outer longer one from the armpit to the heel. Both splints can be tied to the leg and trunk by a belt and strips torn off from the clothing.

In exceptional cases, when nothing is available for splints, the broken leg can be tied to the sound one.

**Fractures of the leg** differ in character and severity. Fractures of both bones at the middle and lower third of the leg are most severe.

No less severe are fractures of the shin-bone (tibia) at the same level.

Isolated closed fractures of the ankle bone are considered less severe.

Signs of a fracture of the middle of both leg bones are sharp pain, deformation, thickening, and distortion, abnormal mobility, and grating at the site of the break. A projection of one of the fragments is often felt at the front edge of the tibia.

The same signs are observed in a fracture of the tibia alone but the deformation is less marked because the undamaged fibula to a certain extent serves as an 'inner splint' and prevents sharp displacement of fragments of the injured tibia. As the front of the tibia is covered only by the skin, which is easily torn by the sharp end of the broken bone, the fracture can become open.

**Fractures of the ankle bones** cause pain in the area of the outer or inner ankle bone and swelling, haemorrhage, sharp restriction of movements in the ankle joint, and inability to stand on the foot.

*First aid.* A splint is applied and a pain killer administered.

**Fractures of the metatarsal bones** occur in the foot being struck by heavy objects falling on it, or run over by the wheel of a vehicle, and so on.

The signs of a fracture include pain at the instep, rapid swelling, and haemorrhage, and inability to step on the toes.

*First aid.* The foot and ankle joint should be immobilized. When no such means are available the foot can be

immobilized by binding it with a triangular bandage.

**Wounds of the large joints** (hip, knee, shoulder and elbow) are grave injuries that very often cause invalidity and are dangerous to the patient's life. Wounds with extensive destruction of the articular surfaces of the joint, complicated by infection, have a grave course.

The wounded joints are recognized by pain during movement, swelling around the joint, the smoothness of its contours, and marked restriction of movements.

*First aid.* A sterile bandage is applied to the wound, analgesic drugs administered and the joint properly immobilized.

## ELECTRICAL INJURIES

Electrical injuries are caused by the effect of a high-tension electric current or atmospheric electricity (lightning). An electric current produces general disturbances in the organism, disturbances of the higher nervous system and of the cardiovascular and respiratory systems. Spasm of the diaphragm and muscle of the heart, convulsions of the skeletal muscles, and loss of consciousness occur.

The heat generated when an electric current passes through the tissues causes deep burns at the exit and entrance of the current. The current sometimes leaves a trace on the skin. Electric current, by exerting thermal, light and mechanical effects causes extensive and deep destruction of tissues.

Electrical injuries are often accompanied with shock: the initial paralysis of the heart, respiration, and brain may cause death (electrocution).

With an electrical injury a state of suspended animation may develop characterized by acute functional disturbances and weakening of functionally important organs, and almost complete absence of signs of life.

The effect of electric current on humans is intensified by damp clothing and footwear, and wet hands, which increase electrical conductivity. In such conditions even a 220 V current can cause severe injuries.

*First aid.* If the victim is still under the effect of the current (an electric wire lying on him or through holding a bare wire in his convulsed hand), it must be rapidly switched off—throwing the knife switch, unscrewing the fuse, removing the plug from the socket, or

lifting the wire from the victim's body by means of something that does not conduct electricity. The person rendering first aid should stand on something dry and isolating, e.g. a board or rubber mat.

When the injured person has been freed from contact with the current, artificial respiration should be begun immediately and, when necessary, external cardiac massage. All measures to resuscitate the victim should be carried out persistently and for quite a long time.

Only pronounced signs of death (the appearance of cadaver spots and stiffening) can indicate the hopelessness of further attempts at resuscitation.

When the injured person has come to, he should be given plenty of liquid, an aseptic bandage should be applied to the burn area, and he should be put on a stretcher, covered with a blanket and taken to hospital.

## BURNS AND SCALDS

Burns and scalds are injuries caused by contact with heat, electricity or aggressive liquids (acids and alkalis). Thermal, electrical, chemical and radiation burns are distinguished, depending on the aetiological factor.

Thermal burns may be caused by a naked flame, boiling water, red-hot metal, molten plastics, resins, bitumen, asphalt, etc.

Electrical burns are produced with bare wires carrying high-tension current.

Chemical burns are caused by the effect on the skin and mucous membranes of caustic chemicals, strong acid and alkaline solutions, iodine, potassium permanganate, phosphorus, etc.

In thermal burns the skin, which serves as a defensive covering, suffers first. The degree of damage depends mainly on the type and duration of the exposure to high temperatures. The thermal limit of human tissues is around 45°C. The skin can prevent penetration of heat deep into tissues, so that its thickness in various areas of the body is relevant; the thin skin of the face and palms of the hands, for instance, suffers deep burns more frequently than the skin of the back and shoulders.

Burns may be superficial or deep. In superficial burns only the upper layers of the skin are damaged, while its

growing layer or other elements from which it can be regenerated are preserved.

In deep burns all sources for the growth of epithelium die and a wound formed with a diameter greater than 5 to 7 cm cannot be epithelized and requires skin grafting.

In the USSR four degrees of burn are distinguished (in other countries six).

In **first-degree burns** the surface layer of the skin consisting of epithelial cells is mildly damaged. The skin reddens, swells and is painful. All these symptoms disappear in two or three days without treatment and the burn leaves no traces apart from mild itching and peeling.

In **second-degree burns** blisters filled with a yellowish fluid form on the reddened skin either immediately after the burn or a bit later. When they break a painful wound with a bright-red floor is exposed.

If the burn is not infected its contents resolve in four or five days, or the blisters burt and dry up. The epidermis, the surface layer of the skin, or scarf skin regenerates without scarring.

**Third-degree burns** are characterized by deeper damage and more marked necrosis of the tissues and the formation of a burn scab, a quite dense light-brown to black crust.

In the USSR the third-degree burns are divided into III-A and III-B degree burns. This is of importance in principle because epithelial elements, which are the source material for healing of the wounds without scars, are preserved in III-A degree burns, while in III-B burns all germinative skin layers are completely lost.

**Fourth-degree burns** (in the Soviet classification) are attended with charring and affection of the deeper tissues, viz. the subcutaneous fat tissue, muscles, and bones. Thus first, second, and third-A degree burns are considered superficial, while those of the third-B, and fourth degrees are deep. The severity of the burn is determined by its depth and area affected.

A superficial burn that involves even more than half of the surface of the body usually does not cause severe disturbances in the organism, while a deep burn affecting only 10 or 15 per cent of the surface threatens grave complications associated with the development of burn

sickness which is very difficult to treat because all systems and organs are involved.

There are several periods in the course of burn sickness, the first, earliest one, is known as the period of burn shock. Burn shock lasts one or two days, has no clear clinical picture and is displayed by meagre symptoms: general weakness, fatigue, inhibition, and quickened pulse. In particularly grave cases there may be a drop in blood pressure, and a marked reduction of urine, which may be dark and have a scorching smell. Whether burn shock will develop can be judged to some extent by the extent of the burn.

The simplest methods for quick determination of the extent of the burn are the rule of nine and the palm rule. It has been established that in adults the area of the head and neck constitutes 9 per cent of the body surface; each arm also 9 per cent; legs 18 per cent (i.e. 9 per cent $\times 2$), the front of the chest and trunk 18 per cent, the back of the trunk 18 per cent, and the area of the perineum 1 per cent. Guided by these figures the area of the burn can be determined quite reliably. It can be supplemented by application of the palm rule. The area of the palm is 1 per cent of the area of the body; measuring the affected area by the palm one can determine its size.

*First aid.* The action of the damaging factor (flames, hot water, vapour, molten adhesives, an electric current, aggressive liquids) must be stopped as soon as possible.

A person whose clothing has begun to burn should not run, because draft of air during running not only does not blow out the flames but fans them; and the vertical posture of the body encourages spread of burning to the face and hair and damage to the respiratory tract from inhaling scorching air. It is better to lie down on the ground, flat on the back, and try to remove the burning clothes or beat out the flames. The site of burning should be covered tightly by a blanket, overcoat, tarpaulin or sand, earth or snow, to prevent access of air to the burning surface. When that is not possible, the victim should press the burning spot closely to the ground.

Bits of clothing adhering to the skin should not be torn off and where necessary cut around. The remaining clothes should be left in place if they are not burning or wet.

Strange as it may seem, the most unsuitable methods of rendering first aid in burns are still used in everyday life and the home. For example, burns are smeared with oil, powdered with starch, wiped with urine or aniline dyes, and so on.

Everyone should know the rules of first aid for burns, since a victim's life often depends on how promptly and correctly they are applied.

Resuscitation (massage of the heart and artificial respiration) is carried out only when there are special indications.

When the heart and respiration cease it is necessary to establish the area of the burn and attendant injuries as soon as possible.

Resuscitation is only carried out when the area of the burn is small, i.e. when stoppage of the heart has been caused by an electric shock or attendant mechanical injuries and not by the severity of the burn.

To relieve pain and prevent spread of the burn deeper into the tissues, the burnt surface should be cooled with a stream of cold water for 15 to 20 minutes after the trauma, or by a towel soaked in icy cold water. When the area of the burn is more than 15 or 20 per cent of the body surface excessive cooling is dangerous because of the possible fibrillation of heart ventricles. The burnt surface should be covered with a dry sterile bandage. A victim with extensive burns is simply wrapped in a clean sheet. The damaged skin of the face is smeared with vaseline oil (petroleum jelly) and left uncovered. When possible, an analgesic (promedole) is injected subcutaneously. In cold weather care should be taken to keep victims warm.

A mixture of salt and alkali should be given to thirsty patients (one teaspoonful of table salt and half a teaspoonful of soda in a litre of water).

When chemical burns are caused by acids and alkalis (especially to eyes) the injured area should be washed copiously with water.

The question of transportation of the victim is settled at the spot of an accident. With a small area of superficial burn (up to 10 per cent) and a satisfactory general condition of the injured persons, when they can move without help and do not need hospital treatment, they are taken

to the nearest accident or first-aid post, or doctor's surgery.

The following are the indications for hospital treatment:

(1) first- and second-degree burns involving more than 10 per cent of the body surface and deep burns;

(2) burns of the respiratory organs, face, and neck;

(3) burns of important areas of the body (as regards function and cosmetic appearance), such as the hands, feet, large joints, perineum;

(4) burns combined with other types of injury and those developing on a background of attendant diseases of the heart and blood vessels, lungs, liver, kidneys, etc.

## FROSTBITE

**Frostbite** occurs through long exposure to cold. The peripheral parts of the body, i.e. fingers and toes, nose, ears, and cheeks, which are poorly protected from cold, are most susceptible to frostbite.

Frostbite does not necessarily occur during frost but can occur when the temperature of air is 0°C or when there is a damp cold, sharp wind, or when shoes are wet and tight and have not been removed for a long time.

Factors predisposing to frostbite are general weakening of the organism through loss of blood, starvation, vitamin deficiency, cardiovascular diseases, and fatigue. The continuing action of cold leads first to extension and then spasm of the blood vessels, which disturbs the nutrition of tissues, makes them grow partially or fully numb. Four degrees of frostbite are distinguished, depending on the severity of these changes.

First-degree frostbite is characterized by damage to the skin displayed in reversible disturbances of circulation. The skin turns pale and becomes insensitive and after warming is bluish-red, painful, and swollen. Peeling is sometimes observed. All the morbid phenomena pass in a few days but the frostbitten part of the body is sensitive to cold for a long time after.

In second-degree frostbite blisters filled with a cloudy fluid form on the skin of the affected area, which turns reddish-blue.

In third-degree frostbite the whole thickness of the

skin grows numb, and the affected tissues become hard to the touch.

In fourth-degree frostbite all the soft tissues and bones are affected. The numbed tissues are apt to die, and amputation stumps which take a long time to heal form leaving coarse scars.

*First aid.* The frostbitten part of the body has to be warmed in a bath for one hour, gradually raising the temperature from 20 to 40°C. The affected area should be massaged at the same time from the periphery to the centre until the skin becomes red and warm. When a bath is not available the affected area can be warmed by rubbing it first with a cotton wool soaked in spirit and then by clean, dry flannel.

The affected area must not be rubbed with snow or massaged with dirty hands. It and adjoining skin are painted with a 5 per cent iodine tincture and covered with an aseptic bandage.

General measures to improve circulation are carried out, in addition to local ones. The victim is warmly wrapped and given hot tea, coffee or liquor, and an analgesic to relieve pain.

**General freezing** sets in after long exposure to cold when the body cannot produce sufficient heat to maintain life. Lowering of the body temperature to 20-22°C is usually fatal. Freezing is promoted by loss of blood, starvation, general exhaustion, and alcoholic intoxication. A person freezing first feels strong shivering followed by fatigue and irresistible drowsiness; his arms and legs grow numb, respiration and heart activity weaken. In the absence of prompt help a freezing person dies asleep.

*First aid.* A freezing person has to be warmed slowly using all means available, either cautiously rubbing his body or putting him into a bath and gradually rising the temperature of the water. Once the body becomes malleable and flexible artificial respiration and massage of the heart should be started immediately.

## SUNSTROKE AND HEATSTROKE

Heatstroke occurs from overheating when the body cannot adapt itself to high temperatures. Disturbances of hormoregulation can arise in people in crowds or those

who work in poorly ventilated premises. If at the same time the head is uncovered and exposed to the action of the sun sunstroke occurs.

The first signs of sunstroke are headache, ringing in the ears, weakness, nausea, giddiness, and thirst. If the affected person is still exposed to the sun his state deteriorates: the pulse weakens and quickens, breathing becomes superficial, pain in the stomach and looseness of the bowels develop. In very grave cases there are convulsions, vomiting, anxiety, and loss of consciousness. The skin becomes red and hot, the pupils dilate, and temperature rises to 40°C.

All these symptoms develop more rapidly in heatstroke than in sunstroke.

*First aid.* The victim should be taken into the shade, his neck and chest released from constricting clothing, and cold compresses applied on his head, chest, and neck. He is given cold water to drink. If consciousness is lost and breathing ceases, artificial respiration should be carried out.

## ARTIFICIAL RESPIRATION AND EXTERNAL MASSAGE OF THE HEART

Grave traumas with damage to the brain, and organs of the chest and abdomen, particularly those attended with heavy loss of blood, can considerably disturb vitally important functions, especially circulation and breathing.

Circulation is the continuous flow of the blood in the vascular system, which is governed mainly by the contractions of the heart. It supplies all the tissues of the body with oxygen and nutrients, and removes the breakdown products of metabolism.

Rhythmic contraction of the heart ensures a flow of blood in two closed systems known as the greater and lesser circulation. The greater circulation begins from the left ventricle to the aorta through which all the blood pumped by the left ventricle passes. The blood then flows through all the branchings of the large and small arteries to the cells of the body, delivering the necessary nutrients and oxygen to the tissues and carrying away breakdown products and carbon dioxide, and finally enters the right atrium via the veins. The venous blood

saturated with carbon dioxide thus accumulates in the right side of the heart. In order to be altered to arterial blood it must pass through the lungs where gas exchange takes place; the carbon dioxide escapes and the blood is saturated with oxygen. This is the lesser circulation; it begins at the right ventricle and ends in the left atrium, into which blood saturated with oxygen in the lungs and made arterial enters. From the left atrium arterial blood is sucked into the left ventricle and from here emerges into the greater circulation via the aorta. The oxygen carrier is haemoglobin—a pigment contained in the formed elements of the blood, i.e. in the red blood cells or erythrocytes. In order to maintain circulation of the blood and the normal metabolic processes intensive contraction of the heart is needed. It creates a pressure in the large arteries equal to a column of mercury 120 to 130 mm high. This blood pressure is known as maximal. When the heart muscle relaxes pressure drops to 70-80 mm Hg, which is the minimal blood pressure. The work of the heart and the state of the circulation can be assessed by the rate and force of the cardiac contractions.

The respiratory organs consist of the larynx, trachea, bronchi, and lungs. Respiration is an exchange of gases between the body and its surroundings. During inhalation the chest widens, and the lungs expand and suck in air, which enters the lung vesicles or alveoli of the lungs, the thin walls of which have very fine blood vessels. Gas exchange occurs in the alveoli; carbon dioxide escapes from the venous blood flowing into the lungs, which becomes saturated with oxygen.

During expiration air with less oxygen but an increased content of carbon dioxide is expelled from the lungs.

Breathing, i.e. inhalation and expiration, are regulated by an automatic respiratory centre in the brain. The nerve cells of this centre respond to the amount of carbon dioxide dissolved in the blood and when its amount increases breathing quickens.

The severity of the state of the victim depends on the degree of disturbance of the circulation and respiration.

Anyone rendering first aid must quickly appreciate the situation so as to determine the urgency, order, and character of the measures needed.

Is the injured person alive or dead?

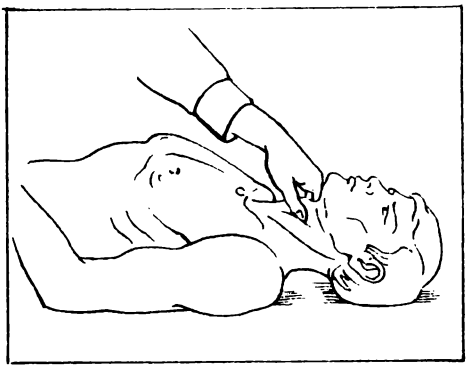


Fig. 51. Detection of pulsation in the carotid artery

That question can be answered by carrying out a very simple examination of the state of the circulation and respiration.

Cardiac contractions are detected by listening for heart sounds by pressing ear to the left side of the victim's chest at the level of the nipple, and by determining the pulsation of the large arteries (radial, femoral or carotid). When cardiac contractions are weak, the pulse wave does not reach the periphery of the body and the pulse on the radial or femoral arteries may not be felt. The carotid artery located in the neck close to the heart usually pulsates even with very slight contraction of the heart. Pulsation of the arteries shows that the heart is working.

The pulse of the carotid artery is detected as follows: feel the thyroid cartilage (or Adam's apple) at the front of the neck by the thumb on one side and by the index and middle fingers on the other, sliding them back toward the direction of the spinal column. If the heart is contracting pulsation of the carotid arteries will be felt by the tips of the thumb and fingers (Fig. 51). External respiration is detected from the rhythmic movements of the chest expanding and rising during inhalation and falling during expiration.

If breathing is so weak that it cannot be detected, a mirror should be applied to the victim's mouth and nose. Fogging of the mirror shows that breathing is self-maintained.

Normal person's pupils have a marked reaction to light. If a flashlamp is shone on the eyes the pupils will contract. In daytime this reaction can be checked by covering the victim's eyes by the hand and then quickly withdrawing it. Contraction of the pupils in the light shows that the person is alive, but the reaction may be absent in deep loss of consciousness.

With stoppage of the heart and breathing metabolism is sharply disturbed. The flow of blood carrying oxygen to the cells ceases and they die of oxygen hunger. Death, however, does not occur instantaneously.

The highly organized nerve cells of the brain are particularly sensitive to lack of oxygen, and die in five to seven minutes after stoppage of the heart. If circulation and breathing are restored during this period known as clinical death the victim's life can be saved. Later, eight to ten minutes after heart arrest, irreversible changes develop in the cells of the cortex and biological death sets in, and then the victim cannot be revived.

There are relative and absolute signs of death. If heart beat cannot be detected and the injured person does not breathe, does not respond to the pricking of a needle, and the reaction of his pupils to light is negative, there is still reason not to refrain from life-saving measures, which should be continued until one is quite sure of their obvious hopelessness. This is determined by the presence of absolute signs of death: a cloudy dried cornea of the eye, cooling of the body, cadaver spots and stiffening of the body. When the sides of the eye are pressed by the fingers the pupil contracts in a peculiar way resembling 'cat's eye'.

Cadaver spots begin to form after death from congestion of blood flowing by gravity to the lower parts of the body. In a dead person lying on his back they form on the shoulder blades, loins and buttocks; when the corpse is lying on its belly the spots form on the face, chest, arms, and legs. Stiffening (rigor mortis) begins two to four hours after death and consists in a hardening of the muscles, so that it is impossible to turn the head of the corpse or bend or unbend a limb.

Stoppage of breathing may be connected with external factors that prevent air from passing into the respiratory tract, such as retraction of the tongue, when an injured person is unconscious, or foreign bodies plugg-

ing the mouth, throat, or a windpipe (vomit, water, dirt, mud, various solids, or food).

The root of the tongue of an unconscious injured person lying on his back sinks down (is retracted) into the throat and obstructs the flow of air into the windpipe. It is due to relaxation of the muscles of the tongue and throat. In this case there are breathing movements of the chest, but the breathing sounds usually originating from inhalation and expiration, are not heard and no flow of air is felt.

The same may be observed when the windpipe is blocked by various foreign bodies, most commonly by vomit getting into the respiratory tract during inhalation, and by water and mud in drowning. When there is partial obstruction of the upper respiratory tract by a retracted tongue or a foreign body, convulsive noisy breathing is heard, with a hoarse sound during inhalation.

Weakened breathing movements, bluing of the skin and lips, acceleration of the pulse up to 110 and more beats per minute are indications for assisted ventilation of the lungs, i.e. artificial respiration.

Before artificial respiration is begun the person rendering first aid should check that there is no blockage of the airway in the respiratory tract. The mouth should be cleansed of vomit or dirt and water removed from the

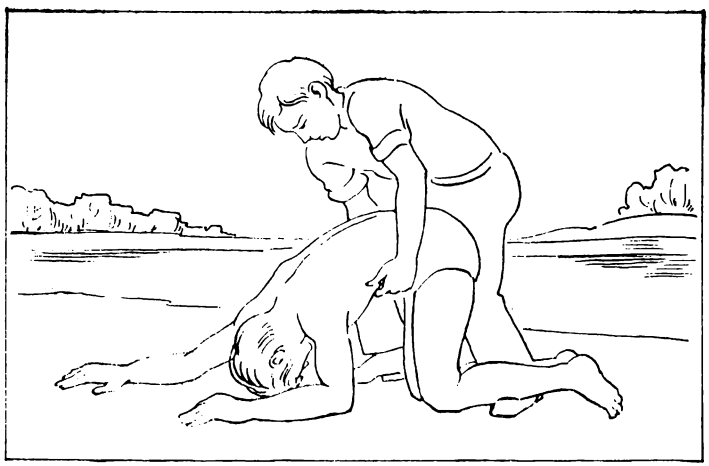


Fig. 52. Removal of water from the lungs in drowning

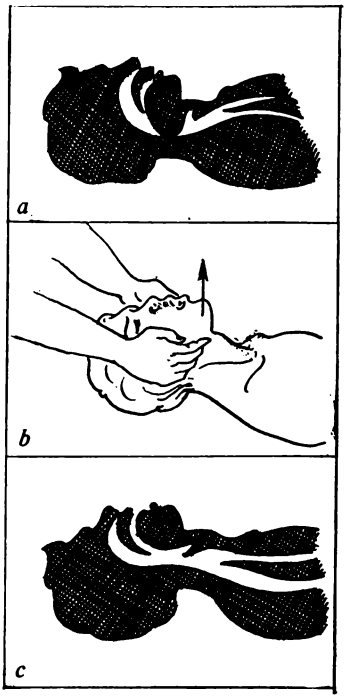



Fig. 53. Control of retraction of the tongue

*a*, the root (the back) of the tongue has blocked the throat; *b*, *c*, by pushing the lower jaw forward the tongue is shifted and entry to the upper respiratory tract restored

lungs (in drowning) (see Fig. 52). A drowning person is laid with his chest on a barrel or cylinder or across the knee of a rescuer, with the upper part of his body dropping; the rescuer presses the chest with his hands. Not much time should be spent trying to remove water from the lungs, as there may not be any, and artificial respiration should be begun without wasting time.

The most efficient method of artificial respiration is to blow air into the lungs through the mouth or nose (mouth-to-mouth or mouth-to-nose artificial respiration—the 'kiss of life'). This can be done by using the air exhaled from the rescuer's lungs, which contains sufficient oxygen and is quite suitable to sustain the victim's life.

In order to create the most favourable conditions for passage of air into the respiratory tract the victim is laid flat on his back, his head tilted, and his lower jaw advanced forward (Fig. 53). When the head has been drawn back the root of the tongue moves away from the back of the throat, so freeing entry to the throat and trachea (this occurs in 80 per cent of injured persons who lose consciousness).

In order to tilt the victim's head back put one hand under the back of his neck and press his forehead with the other. The victim's mouth will open. If this does not provide full opening of the respiratory tract (the air blown in does not pass into the lungs and the chest does not rise), the lower jaw should be advanced for-

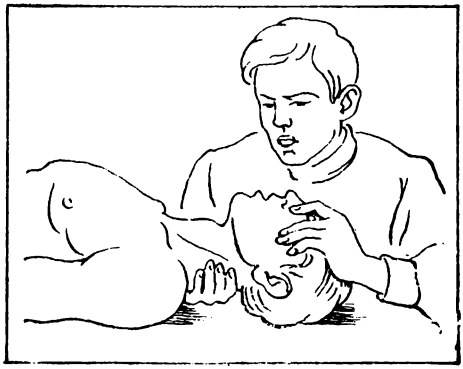


Fig. 54. Mouth-to-mouth artificial respiration. The rescuer tilts the victim's head, pinches his nose with the fingers of the left hand and takes a deep breath

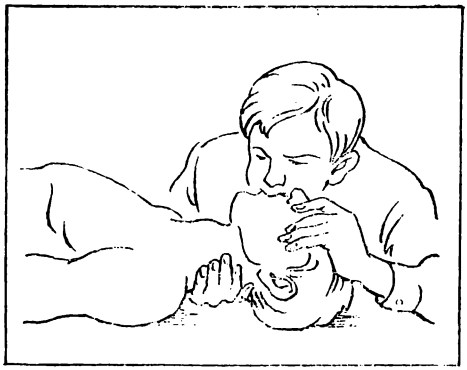


Fig. 55. Tightly pressing his lips to the victim's mouth the rescuer blows air from his lungs into those of the victim

ward as follows. The patient is laid on his back, the rescuer grasps the angle of the lower jaw from behind by four fingers of each hand. Then pressing his thumbs on the cheek bones he pushes the lower jaw forward so that its teeth are in front of those of the upper jaw.

When the head is drawn back and the lower jaw is shifted forward, the tongue does not usually retract and the respiratory tract is open.

With spasm of the upper and lower jaws it is very difficult to cleanse the mouth and start artificial respiration. Various methods are used to open the mouth: one is to put the index fingers behind inside the cheeks and run their tips behind the back molars, trying by rotatory movements to insert them between the jaws and open them.

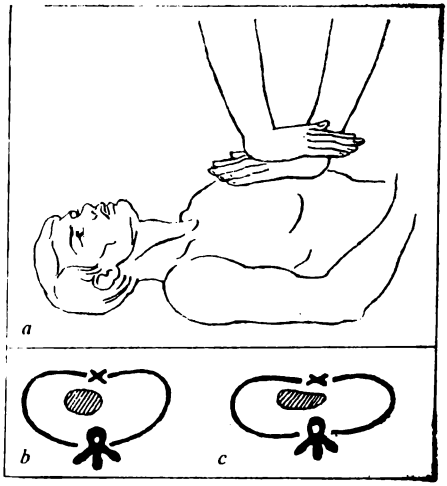



Fig. 56.
*a*, external heart massage; *b*, *c*, diagram of a cross-section of the chest; *b*, by pressing on the breast bone blood is expelled from the heart to vessels; *c*, after pressure is stopped the heart expands and is again filled with blood

When the victim is relaxed his mouth is opened by crossed fingers and the lower jaw drawn down by pressing on the chin. The rescuer then pinches the patient's nose, takes a deep breath and begins mouth-to-mouth respiration by blowing expired air into the victim. Inhalation occurs. Expiration is passive and occurs through independent falling of the ribs because the muscles of the chest and the diaphragm are relaxed. With children air is blown simultaneously into the mouth and nose. The breaths are made rhythmically, 16 to 20 times a minute (see Figs. 54 and 55).

In order to restore pumping of a stopped heart chest massage is carried out which consists in rhythmical compression of the chest to expel blood into the vessels from the heart and restore blood flow.

The heart is located in the chest between the breast bone and the spine. If the breast bone is pressed with some force it sinks 5 or 6 cm forward to the spine because of the elasticity of the ribs and cartilages, and compresses the chambers of the heart. Artificial systole thus occurs. Blood is expelled (squeezed out) from the left ventricle to the aorta and flows from it throughout the body and enters, in particular, the brain and the coronary vessels that supply the heart muscle. Blood from the right ventricle simultaneously passes into the lungs where it is saturated with oxygen (Fig. 56).

When pressure on the breast bone is released the elasticity of the chest causes it to expand and the heart is again filled with the blood sucked into it.

Certain rules must be observed when carrying out external chest massage. To prevent fracture of the ribs or of the breast bone which happens more rarely the right place for pressure must be chosen and the appropriate force applied for massage.

The hands are placed two finger's width above the lower end of the breast bone. The breast bone is pressed down toward the spine with the flats of the hands so that it yields by 5 or 6 cm in adults and held in that position for half a second, then released.

Rhythmic compression (massage) of the heart at least 60 to 70 times a minute and simultaneous artificial respiration can restore circulation sufficient to maintain life. In children the heart is massaged with one hand, and in the newborn and infants with the tips of two fingers; the rate of pressure, however, should be accelerated to 100 to 120 times a minute. When the heart is massaged correctly and the breast bone is pressed strongly enough artificially caused pulsation will appear in the carotid and femoral arteries.

In all cases when a grave injury has caused stoppage of heart activity and respiration and there are no absolute signs of biological death, resuscitation should be begun instantly. Resuscitation (reviving) is aimed at maintaining gas exchange in the lungs through artificial respiration and restoring activity of the heart by massage.

External massage of the heart ensures a blood flow of 10 to 30 per cent of the normal, which is sufficient to maintain cerebral circulation and prevent death of the nerve cells of the cerebral cortex.

Resuscitation helps gain time for transporting the victim to a hospital or treatment centre where skilled aid can be provided.

In those cases when the victim has no injuries incompatible with life, prompt correct massage will ensure restoration of heart activity.

**Order and method of resuscitation.** The injured person is laid flat on his back on a firm surface (table, floor, ground), his nose is pinched with the fingers and air is blown several times into his lungs. Heart massage is

begun simultaneously. When aid is being rendered by two persons, one massages the heart while the other carries out artificial respiration. Air is blown into the lungs once for every five squeezings of the heart. When resuscitation is performed by one person, he blows air twice for every 15 presses on the heart.

Every two minutes a brief pause is made to determine restoration of independent heart activity.

The effectiveness of massage is shown by the appearance of a distinct pulse in the carotid and femoral arteries, pinkness of mucous membranes of the lips and skin, and narrowing of the pupils. Drawing back the head and pumping of air into the lungs under pressure, when done correctly, are not dangerous, even if there is no special need for it. But when the respiratory tract is blocked, the bulk of the pumped air may get into the stomach and inflate it badly. This is not dangerous in itself, but it can cause vomiting and vomit may then get into the respiratory tract and block it. If inflation of the upper part of the stomach occurs during mouth-to-mouth artificial respiration the air must be removed from it by pressing on the abdominal wall between the navel and the lowest part of the breast bone.

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Prompt first aid in traumas helps in saving the life of an injured person and lessens the danger of the development of grave complications.

This booklet describes in detail ways and methods for rendering first aid in haemorrhages, wounds, fractures, injuries to the internal organs, burns, frostbite, electrical injuries, and so on.

The booklet is intended for a broad circle of readers.